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THE ECONOMICS OF RAIL TRANSPORT IN GREAT BRITAIN

VOLUME I
HISTORY & DEVELOPMENT

BY

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LONDON

EDWARD ARNOLD & CO.

1928

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Made and Printed in Great Britain by
Butler & Tanner Ltd., Frome and London

FOREWORD

By Sir GUY GRANET, G.B.E.

"The wealth of any country depends very largely on the efficiency of its transport system."

Like all truisms, this requires to be emphasized and explained. Mr. Sherrington in this book has set himself the task of making it clear not only to the trained railway man and the trader, but to the general reader.

In his first volume he has traced the history and development of rail transport in this country. In his second volume, after an introductory chapter on the economic function of rail transport, he explains the organization and the administration of railways, some of their operating methods and objects, and their relations with traders, the public, and the State.

Mr. Sherrington has not only—in the study and teaching of economics and transport questions at Cambridge, Cornell and London Universities—had an unusual equipment for his task upon the academic or theoretical side; he has also had to handle his subjects, with no uncertain grasp, in their practical aspects. As Secretary of the Railway Research Service, located in the London School of Economics, but sustained by and on behalf of our great railways, his reports and surveys of the conditions abroad would be of little use if they were not imbued with a strong practical spirit. And whether it is the result of travel abroad in inquiring into the working of an eight-hour day under the Washington Convention, or car retarders in hump shunting yards, or automatic train control, or the carriage of coal, or rates policies, or operating results abroad, he has brought a grasp of both general principle and practical considerations into service to an unusual degree, and practical railwaymen

are learning to appreciate the qualities of his work to an increasing extent.

There never was a time when the efficient working of our railways was so important to our industries as it is to-day.

I believe that our English railways have attained a high standard of efficiency, and I think it is a good augury for their continued progress that they are making such increasing and practical use of the trained mind of the author of this book; but there is no doubt, as Mr. Sherrington points out, that we are far behind some other countries in co-operative organization with our traders.

If on the one hand he can convince our railwaymen that their equipment is deficient in this respect, and if on the other hand he can induce traders to read this book and to understand some of the difficulties that confront the railways, his labours will have been amply justified.

PREFACE

In writing this book, I have endeavoured to stress the importance of studying the development of the British railway system prior to any attempt at analysing the economics of rail transport at the present time in Great Britain. It is exceedingly difficult to understand the present position and the many problems which surround such questions as the private ownership of railway wagons, the level of rates, and fares, or the organization of the railways in their relationship to the social welfare of the community, without the background of economic history during the last hundred years. Unfortunately, it was found impossible to include the history and development in addition to the discussion of railway economics within one volume without the inconvenience of size, which would seriously detract from the value of such a book. It is hoped, however, that so far as is possible the two volumes will be read in conjunction one with another. The dearth of economic literature concerning transport in Great Britain is acknowledged universally by all those teaching the subject, and this want makes very difficult the verification of facts and figures relative to early railway history. Further, it is clear that developments are taking place every day, so that no book of this nature can be absolutely up-to-date—a tribute in itself to railway progress and efficiency.

I would wish to return the sincerest thanks to Mr. H. Grote Lewin—perhaps the greatest living authority on early British railways, as evidenced by his book, *Early British Railways*, 1801–1844. He has been kind enough to check for me the chapters on Early British Railways, and on the History of the Southern Railway. Railway history must largely be checked by a study of contem-

porary technical periodicals, such as *Heropath's Journal* and the *Railway Times* ; and for modern information, the *Railway Gazette*, the *Locomotive* and *Modern Transport*. While references cannot be made in the book for each individual piece of information, I gladly pay tribute to the valuable work which was done by the technical periodicals during the nineteenth century, and is being done by their present successors. Where so few books exist dealing with the subject, the debt due to the technical press is very large.

To Mr. R. Bell, Assistant General Manager, L.N.E.R., I owe much for his kindness in allowing me to have the history data relative to that Company checked and verified. I owe, also, similar debts of gratitude to Sir Felix Pole, General Manager, G.W.R., and to Sir Josiah Stamp, Chairman and President, L.M.S.R., as also to Mr. Quirey, Vice-President, L.M.S.R. Mr. R. W. Reid, Vice-President, L.M.S.R., has been good enough to assist me with advice as to the chapters on Carriage and Wagon Design ; while Mr. R. E. L. Maunsell, Chief Mechanical Engineer, S.R., kindly commented on the chapter dealing with Locomotive Development, as did Mr. W. A. Willox, of the same railway, with regard to the chapter on Permanent Way.

Although every care has been taken to verify and check dates, figures, and so forth, I realize, notwithstanding, that probably errors have crept in, due to the impossibility in many cases of finding more than one single source of information. My thanks are also due to Mr. Cyril Hurcomb, Permanent Secretary to the Ministry of Transport, for certain figures ; and also to Professor Kidd of Pittsburgh (U.S.A.), Mr. G. J. Ponsonby, Mrs. Clement Edwards, and to my father, Sir Charles Sherrington, for valuable comments. I am also greatly indebted to Mr. P. H. Price and to Mr. Painter, of the Railway Clearing House, for having so kindly checked the chapter on the development of that all-important institution, while thanks are also due to the Railway Economics Bureau at Washington for certain information.

The book is designed to be of assistance not only to

the student of railway economics, but also as a reference book for those in a position of responsibility on the home railways and those abroad. It is hoped further that to economists interested in transport it may prove useful in giving a bird's-eye view of the economic problems of the most vital of home industries.

Lastly, for her invaluable help comprising the verifying of the data cited, I render grateful acknowledgment to my wife.

C. E. R. SHERRINGTON.

May 24th, 1928.

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ECONOMICS OF RAIL TRANSPORT

VOLUME I

CHAPTER I

THE FUNCTION OF TRANSPORTATION

Transportation may be defined as the carriage of persons and goods from places where they are less useful to places where they are more useful. In the case of commodities the latter place is often that where they are consumed or altered by some manufacturing process. With persons it is the place where personal services can be put to maximum advantage, or where pleasure may be most easily obtained.

To effect this transfer of passengers and goods a complicated organization has been gradually built up during the period of which history relates. Like all other economic organizations there is a constant need for improvement to suit a new set of conditions; economics is a dynamic science and no branch of it can be considered more dynamic than that of transport. No single industry is being dealt with, no single group of persons has to be served, any change whatever in any industry or in any branch of society will react immediately on the organization of the machine supplying transport to that industry or society. Conversely changes and developments in the organization of transport facilities will react on society.

The greatest steps forward in this dynamic science have taken place since the Industrial Revolution; the so-called steam age has witnessed the triumph of steam railways over horse-drawn vehicles; the steamship may be said to have driven the sailing vessel from all ocean services. Now, in turn, steam locomotives on land are in

many cases giving way to electric traction. In some cases road traffic with power supplied by internal combustion engines is drawing traffic from railways ; in air the internal combustion engine is supreme ; while on sea the motor-ship is seriously threatening the position of the steam engine on many of the world's trade routes. Many consider that the world has entered on the dawn of an oil age.

Every one of these great changes is bound to leave its mark on the organization of each transport system. Yet, however modified, its function remains primarily the same, namely, to transfer passengers and freight to a place of maximum utility from a place of lesser utility, with a minimum expenditure of energy. Herein lies transport's connection with wealth, and the science of economics has sometimes been styled the study of wealth.

By transferring a ton of coal from the coal-mine to the consumer the last step in a productive progress is accomplished ; admittedly the coal-miner is a productive agent, he finds the coal, he brings it to the surface, he cleans it to a certain extent ; with that his functions cease. It is the railway, the steamship, and the delivery cart or motor of the local distributor which completes the function of production. Here then is the connection between production and transport ; transport is invariably one of the component processes of production ; often transport charges amount to more than 50 per cent. of the final selling price of articles with considerable intrinsic value. In cases such as the export of low-grade goods to the central parts of Africa the transport charges may well amount to several times the price charged at the works or factory in Europe.

Again, in the case of persons, the mining engineer is not able to use his professional knowledge to the best advantage unless he can superintend mine operations on the spot. The manufacturer, whether his factory produces watches, perambulators, or gloves, cannot sell his products unless his representatives can draw the attention of prospective buyers to them. By the sale of the watches, perambulators, and gloves, there is a net gain in wealth,

if we allow that the consumer is in real need of the article he buys. In either case, whether by transferring people or goods, transport acts as one phase of the productive process and contributes to the aggregation of the sum total of social wealth. But there is also another function that transport effects : it tends to the concentration of production where that production can be carried out most efficiently and beneficially.

It might be possible to grow oranges under glass in Great Britain, but in actual practice it is never done on a commercial scale ; owing to highly organized steamship service it is preferable to import oranges from the places where they can be grown with more help from nature and with less help from man, and to exchange for them coal or manufactured products of Great Britain. It might be possible to grow wheat in the Shetlands, but owing to an efficient transport organization a system of territorial specialization has grown up on the basis of mutual exchange. Once more may be seen the effect of transport in the scale, locality and methods of production. In this way transport has affected the consumption of goods by bringing the consumer into close touch with the producer, and by allowing production to be carried out where it can be done with the least expenditure of the factors of production, land, labour, and capital. This permits products surplus to local requirements to be sold more cheaply, thereby increasing the total exchange of goods and trade.

By means of territorial specialization industry can produce on a large instead of a small scale, thereby obtaining the benefits which accrue from that large-scale production, and thus as a consequence still further reducing the selling price of the article. This is especially true in such cases as those of machine products where the percentage of fixed or overhead charges is large. Noteworthy examples of this are the cheaper type of motor-car, the manufacture of pins, garden tools and matches. It is generally acknowledged that the cost per unit of most manufactured articles is reduced as the output from any factory is increased, since the overhead charges, such

as the building, housing the machinery, the depreciation of the machinery, insurance against fire, and the cost of management, must be covered by the total selling price of the articles produced, and the greater the number of units these charges can be spread over, the lower will be the burden of overhead charges per unit. The larger the area which that one factory can serve the lower will the cost be per unit of product, so that people of smaller means can afford to buy it; and the greater the purchasing power of the average citizen of any country the greater is the number of wants which he is able to satisfy.

Since wealth is sometimes defined as the power to satisfy wants, we may say that the more easily wants can be satisfied by the individual, the wealthier is the country. The United States is reputed to be a wealthy country, since it is generally supposed that wants can be more easily satisfied there than elsewhere. The transport system of any country plays a most important part in allowing the average citizen to satisfy his wants more easily than he otherwise could do.

By its very function, transportation permits the collection, from perhaps many different sources, of the various articles to be used in a factory situated where possibly cheap power or highly skilled labour can be obtained, or where possibly climatic conditions favour the conversion of the raw material into the finished or semi-finished product. The cotton industry of Lancashire is situated there not by accident, but partly owing to the humidity and favourable character of the Lancashire climate. Pittsburg, the centre of a great steel district, has abundant coal in its vicinity though in many cases the steel works are situated on the shores of Lake Erie, rather nearer the source of the supply of iron ore. The transportation system alone has made possible the territorial specialization of these great industries; rail or water transport by gradually reducing the cost of moving the raw materials has enabled the growth of large factories obtaining the benefits of large-scale production. The duty of transport, however, by no means ceases there. After the finished product has been completed it must be

distributed, and this again is a function of the transport system. It is of little use to manufacture articles on a large scale if there be no market for them when completed, and the costs of movement must be sufficiently low to enable enough consumers to buy the total output. The larger the output the more difficult will this become and the wider the area over which the selling price must be able to compete with similar articles or possible substitutes.

Hence, the wealth of any country depends very largely on the efficiency of its transport system, and without an efficient system, evidenced by low rates, and perhaps even more important still, by good service, the benefits of large-scale production cannot be attained. There are, it is true, a number of industries which can be as efficiently operated, or even more efficiently operated, on a small scale as on a larger. With such extractive industries as farming, market-gardening, coal-mining, and with industries which cater for the individual taste, there comes a point at which it no longer pays to increase further the size of the business organization ; yet even in their case transport plays an important, though perhaps not so vital, a part. The wheat grown by a farmer who perhaps owns only a few acres is usually, nowadays, converted into flour by the large-scale miller whose function of milling is carried on more cheaply on a large scale than on a small scale. The farmer can improve his crops by special kinds of artificial fertilizer, brought, it may be, from a point thousands of miles away. With the present efficiency of our transport organizations a farmer in Alberta may have his wheat milled in Minneapolis ; the very bread he himself eats is, likely enough, made from flour milled in Minneapolis.

In certain industries the part played by transport is by no means confined to the carrying of the raw materials to the point of manufacture, and the distribution of the finished product. There may be ten or more different processes involved before completion, and between each of these the material has to be transported from place to place. The extreme specialization of the cotton towns

in Lancashire is a well-known example of this type of production.

Such is the function of transport agencies in regard to goods ; in regard to persons, their " passengers," they exercise functions no less important. Cities, originally formed for purposes of protection, have now, as a result of efficient transport, become huge densely-populated centres, for the decentralization of which transport undertakings are endeavouring to find a solution. Further, it is the duty of transport to furnish the means by which such cities can live. Besides the supply of food and other necessities of modern life, there is the housing problem and the problem of holidays, occasioned by the need for change and fresh air. The greater the ease of access to fresh and dustless air, sunshine, and relief from noise, the greater will be the health of any community,—whence the great importance of low passenger fares. While railways have in the last hundred years been a prime factor in promoting the growth of our cities, to them is also due in no small degree the reduction of the death-rate in recent years. Besides that of health there is the question of that organizing power without which the three factors of production would fail to produce. Whether goods or passengers be taken, low cost of movement in their area is a requirement of paramount importance if the citizens there are to enjoy the full advantages of modern civilization.

A further economic function of transportation is the unification of a nation. Fortunately in many ways, tradition dies hard in Anglo-Saxon countries ; each man's county seems to himself the best : those born in Lancashire often harbour some innate sense of superiority to their neighbours of the White Rose ; the Devon man in his own estimation is far superior to his neighbours in Cornwall, even though the former may have been born within one hundred yards of the Cornish border. The Scotchman, perhaps rightly, considers himself of a race apart. Yet race apart or not, few of them have any desire to separate into various nations. If Ireland had possessed rail communication with Great Britain, would not the

so-called Irish problem have been settled by Stephenson, Locke, Hackworth, and their contemporaries ?

If railways had been introduced earlier into the United States, would there ever have been a Civil War ? Railways did not arrive until too late to bind the two sides of the Mason-Dixon line by strands of friendship in the form of steel rails : a striking contrast with the conditions of to-day.

Look where one will in this British Empire, the same principle is at work ; in Canada, the Maritime Provinces, Quebec, and British Columbia, with different problems, varying climates, diverse interests, yet held together by the Canadian National and the Canadian Pacific. In the case of the former, how small its yearly deficit [1] compared to the bonds of friendship which it forges. In Australia, witness the great transcontinental from Port Augusta to Kalgoorlie, welding the various States together. With a uniform gauge for the whole of Australia even more might have been accomplished. Would India exist to-day as one economic unit but for its railway system ? In South Africa, perhaps the best example of all, the co-ordination of a railway system has formed a nation, not a quarter of a century ago riven with unhappy racial dissensions.

Such are the functions of a transportation system, and from them one can see the responsibility a rail transport system possesses to the community it serves ; in short, its efficiency may be judged by its charges. Low rates and the division of labour increase territorial specialization and increase the flow of trade, thereby augmenting the wealth of the community and utilizing its resources to the maximum capacity. Low fares increase the capacity for work of the populace and thus help the movement of commodities. This is one side, but there are other sides also. In return for assisting the communal life and social welfare, what is the duty of the community to the railway organization ? Surely it is to ensure that those who have foreseen the requirements of the nation, and foreseen them correctly, shall not suffer unjustly for

[1] In recent years there has been an important operating surplus.

their acumen. The community thinks it just that those who lend the services of their capital to the country in times of need should be allowed a certain payment each year for the loan of their resources. Yet is not one who lends his capital for the construction of railways equally a public benefactor ? [1] This appears to be the responsibility of the consumer, or collectively of the community, to a railway owner who supplies a long-felt want. But a triangle of responsibilities exists, for there are the employees on the railway, in whose case the responsibility is quite clear ; in return for adequate service both to the employer and to the community, the employee must receive an adequate wage and be cared for well. It is the duty of the community to see that his conditions of service are in keeping with those obtaining in the most progressive countries in this our so-called democratic age. It would seem preferable to regard this triangle as equilateral in form, where no side gains an absolute advantage over the other two.

The following chapters will endeavour to outline the facts which have led up to the position as it exists to-day, and then to discuss the problems and theories underlying the railway industry and its organization. It is regretted that the scope of the book does not leave room for a more detailed discussion of the many problems which fall under the title of railway economics, but an attempt has been made to cover the majority of those problems. Two noteworthy aspects have not been included, namely, the personnel problem and the rapid growth of signalling. The former is primarily a problem of labour economics, and is worthy of a long and detailed study of its own, whilst railway signalling to-day has grown to such an extent the work of the electrical engineer that only its

[1] There is a reasonable argument that the capital so invested may be utilized to build a railway not required ; surely the answer is that the capital will inevitably be lost in the long run, and like most economic phenomena over a long period of time the individual investor who forecasts inaccurately will assuredly be eliminated by the fact that finally he will have nothing to invest.

economic aspects have been mentioned in this short outline.

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CHAPTER II

THE BIRTH OF THE BRITISH RAILWAYS

The Surrey Iron Railway of 1801 was the first railway sanctioned by Parliament, and was opened for traffic in 1805 with a gauge of 4 feet. This railway was built by William Jessop, who transferred the flange from the rail to the wheel. His design of rail, which can be seen in the Science Museum at South Kensington, is remarkably similar to the bull-headed rail of to-day. The railway ran from Croydon to tidewater of the Thames at Wandsworth, when first opened. A later extension of it was the Croydon, Merstham, and Godstone Railway, which received Royal Assent in 1803. Horse traction was used exclusively on these early lines. Close to their old track runs the present line to Brighton. The railway never actually reached Godstone or Reigate as had been originally planned. Double lines throughout, both these companies were dissolved in 1846 and 1839 respectively.

The Kilmarnock and Troon Railway, the Act for which was obtained in 1808, was opened in 1810. It was the first Scottish line, was 9½ miles long, and was constructed to make more easy the shipment of coal at Troon. A steam locomotive is known to have worked on it during the year 1817.

In 1812, a racked railway, designed by Blenkinsop,[1] was at work hauling coal from the Middleton Collieries to Leeds, and in the following year Hedley's "Puffing Billy" was at work at Wylam on coal haulage. It is noticeable that these lines and about fifteen more of a similar type, though scattered over the country from Scotland to South Wales, were primarily built for coal

[1] Blenkinsop (1783–1831) has been described as the inventor of the first locomotive to achieve any commercial success.

haulage only. Thus, it is really a result of our coal deposits that to Great Britain belongs the honour of first running the railway. None of these lines, however, can be regarded as public railways in the modern sense of the term, and, although persons no doubt did at times ride in the empty coal wagons, it was the prospectus of the Liverpool and Manchester Railway, issued in 1824, which first broached the idea of a railway among whose main sources of revenue might be passenger traffic.

Even the Stockton and Darlington Railway, authorized in 1821 and opened in September, 1825, was built primarily for the coal traffic to Stockton, although it was hoped to secure as well a considerable amount of local traffic, serving the countryside through which the line passed. The necessity of connecting the rich coal area of Durham to tidewater by means of a system of transport which could carry bulky material at a cheap cost was the main cause of the building of the railway. More by accident than otherwise it happened that no canal existed to obviate, for a time at least, the need for a coal-carrying railway. The Stockton and Darlington was, however, the first line to combine steam locomotive haulage with the definite booking of passengers, and it was due to this combination of circumstances that the railway centenary celebrations were held at Darlington in July, 1925. One of the main features was a historical procession of locomotives and rolling stock showing the development from the original designs to those of the present day.[1] George Stephenson (1781–1848), after a first survey for it, conducted a second in 1821. In 1822 he became engineer to it, and in that year the first rail was laid at Stockton, and the first two locomotives were ordered. These, built in Stephenson's shops,[2] cost about £500

[1] For a history of its opening and construction reference should be made to *The Railway Centenary ; A Retrospect*, by Randall Davies.

[2] Under the name of Robert Stephenson & Co., this firm has built, since 1832, over 4,000 locomotives. They moved to Darlington in 1902 from the Forth Street Works, Newcastle, where they had been established in 1823 under the name of G. & R. Stephenson, Pease, & Richardson.

apiece. In spite of great opposition, the line was ready and was opened in September, 1825. Its trains were permitted to run during the day only.

It is a far cry from the Stockton and Darlington Railway, in a countryside already busily exporting mineral wealth and considerably developed, to the quiet cathedral city of Canterbury, the middle of an agriculture region, yet this was the scene of the opening of the second public railway, the traction of which was steam locomotive power. Possibly Canterbury may yet become the centre of an important Kent coalfield, but a hundred years ago there was little thought of developing such a field by joining Canterbury to the coast by means of a railway. The main cause of the construction of the Canterbury and Whitstable Railway was the silting up of the river Stour, as a result of which Canterbury lost its shipping trade, which consisted largely of imported coal. Just as the Stockton and Darlington Railway was the alternative to a water route, so the original scheme was to improve the navigation of the Stour to Sandwich, but eventually this was abandoned and it was determined to build a railway to Whitstable, which would then act as a port for the city of Canterbury. John Dixon, one of the moving spirits of the Stockton and Darlington Railway, was sent by George Stephenson to survey a suitable route. He was impressed by the absence of engineering difficulties to be surmounted, but the local gentlemen desired a tunnel as a feature of their line which, it was expected, would attract passengers by its novelty. Stephenson, therefore, had the line redesigned and provided with the required tunnel, which necessitated some severe gradients, such as 1 in 28, and stationary engines. The company was promoted by twenty-four people, the Act received Royal Assent in 1825, and the opening ceremony of the 6-mile line took place on May 3, 1830. The line can claim to possess the world's first railway tunnel, half a mile in length, but the cost, due to this luxury, up to the day of opening was £71,000 instead of the original estimate of £31,000. The first train was headed by Stephenson's locomotive "Invicta," a four-

wheeled engine with its two axles coupled, which had been brought to Whitstable by sea. In 1829 Stephenson supplied the first steam locomotive to the Sirhowy Tramroad, a short mineral line connecting the Tredegar Ironworks with the river Usk at Newport. The line had previously, since its opening in 1805, been worked by horse-traction.

As has been mentioned above, the prospectus of the Liverpool and Manchester Railway was issued in 1824, and the line was finally opened in 1830, the year after the Rainhill trials in which Stephenson's "Rocket" gained the prize of £500. The Act for the Liverpool and Manchester Railway was passed in 1826, and permitted the line to be either a railway or a tramway from Liverpool to Manchester. George Stephenson was responsible for the adoption of a railway rather than a tramroad, but stationary engines were used for the inclines at Liverpool and Sutton.

As with the Stockton and Darlington Railway the Liverpool and Manchester Railway had to face bitter opposition from the local landowners and also from the canal companies, which last named feared the loss of part of their traffic. But the business men of Liverpool and Manchester considered better communication between the two cities essential to the development of their trade, and George Stephenson finally carried out the work.

When the proposed Liverpool and Manchester Railway Bill came up before the Committee of the House of Commons in 1825, it encountered such opposition that it was finally withdrawn. A new Bill, resulting from a new survey by Vignoles, who altered the route somewhat, was later passed by a large majority, though in face of obstinate resistance. There can be little doubt that the dominant idea in many of these early lines footing at tidewater,—the Surrey Iron Railway at the Thames, the Stockton and Darlington at the Tees, and the Liverpool and Manchester at the Mersey,—was to provide land transport by which bulky products of low value like coal, arriving or leaving by ship, might be carried cheaply

without breaking bulk to the extent of the 1-ton lots carried by horse carts.

Although promoters of the Liverpool and Manchester Railway relied chiefly on heavy merchandise traffic for their revenue, George Stephenson foresaw the future that awaited the railways in the carriage of passenger traffic, when he expressed the wish that he might live to see the day "when it would be cheaper for a poor man to travel by railway than to walk."[1] Passenger traffic on this railway, however, exceeded expectations, and passenger revenue, instead of the estimated £10,000 for the first year, greatly exceeded £100,000. By the middle of the thirties, the line is reported to have been carrying passengers at the rate of 500,000 persons per year. Amongst the evidence given by Mr. Booth on the Birmingham Railway Bill, when the latter came before Parliament, was the following:

"During the first twenty-two months after its opening, the Liverpool and Manchester Railway carried 669,211 passengers, or 1,200 per day. By a first-class train the time occupied was 90 minutes and the fare 5*s*. By a second-class train the time was 120 minutes and the fare 3*s*. 6*d*.

"Before the railway was opened about twenty-two regular coaches ran between Liverpool and Manchester with about six extra in summer; the number of passengers per day was 450. The average weight of a passenger was 149·33 lb. and each passenger's luggage 28 lb.

"The repairs of the engines cost £18,343 6*s*. 4*d*., or 0·342 pence per gross ton mile. Average speed of haulage was 16·73 miles per hour. Engines in daily use were normally ten. Canal charges for carriage of cotton before the railway was established were 15*s*. per ton, and the time of trip twelve hours. After the railway was opened the charge by canal or railway was 10*s*. Mail went three times a day each way, and 700 to 800 persons were in constant employment. The amount of the first estimate was £500,000 and actual cost £800,000."[2]

[1] *The Story of the Life of George Stephenson*, by Samuel Smiles.

[2] This last statement appears to have been incorrect.

A trial run of the "Arrow" was made over the whole length of the line from Liverpool to Manchester just three months before the official opening on September 15. On the return journey, the "Arrow" is said to have attained 27 m.p.h., a speed which was later exceeded on the opening day by the "Northumbrian," which was said to have reached 36 m.p.h., when carrying the fatally injured Huskisson from Parkside to Eccles. One result of the unexpected popularity of passenger travel was that all the locomotives were required for the passenger service and it was not until later that freight trains were run. The first goods train was hauled by the "Planet" on December 4th, 1830, and consisted of eighteen wagons; the net tonnage of the train was estimated as 51½ tons and the gross tonnage as 75 tons, both exclusive of locomotive and tender.

Eight locomotives, all built at the Stephenson works, figured in the procession on the opening day,—George Stephenson driving the "Northumbrian" at the head of the procession; Robert Stephenson (1803–1859), his son, driving the "Phœnix"; Robert Stephenson, senior, George Stephenson's brother, driving the "North Star"; Joseph Locke driving the "Rocket"; while the rear four engines were the "Dart," "Comet," "Arrow," and "Meteor." As a result of the sad accident to Huskisson (1770–1830), the later part of the opening proceedings was not wholly joyful, but the practicability of steam locomotion had once more been proved up to the hilt, and George Stephenson's confident faith in his locomotives had been amply justified.

But if the popularity of passenger travel had been under-estimated by the promoters, so also had the financial cost of building the line, and the original estimate of £800,000 had been exceeded by 50 per cent., much of which had been expended in Parliamentary costs and placating landowners, although the engineering difficulties encountered in building the line across Chat Moss account for a large part of this excess. The railway possessed a four-line entrance to its Liverpool station at Crown Street and its Manchester station at Water Street,

and it was not until several years later that the expensive extension to Lime Street, Liverpool, was undertaken.

This problem of Parliamentary and legal costs and placating of landowners is one too often forgotten when British railway rates are compared with those of foreign countries. In newer countries, not only did the railways receive grants of land free in return for constructing the railway, but they were actually subsidized to build the lines by cities, local authorities, or central governments. By a curious coincidence, it must sometimes occur that the descendants of large landowners, who obstructed the passage of the railways through their lands for the undesirable effect it might have on pheasant preserves, are to-day loud in their complaints of the effect of high rail charges on their agricultural produce. The pheasants themselves appear to have more quickly become accustomed to the new conditions, and large broods are hatched each year on sunny railway embankments. It should be remembered that the unduly high first costs of our early railways can never be eliminated, and they will always remain a permanent charge against the industrial efficiency of this country and a lasting reproach against a short-sighted set of nineteenth-century gentlemen.

An early Scottish line was the Monkland and Kirkintilloch, the first public passenger line in that country, an Act of Parliament for which was obtained in 1824, and which was opened in 1826. Permitted by its Act of Incorporation to build and maintain locomotives, this line, constructed originally as a single line, ran a distance of 11 miles northwards from Monkland Collieries to the Forth and Clyde Canal at Kirkintilloch, and possessed two short branches. Though designed for the carriage of coal, it was also permitted by Act of Parliament to carry passengers, and apparently the enterprise met with considerable success, as the line was doubled not long after its opening.

Acts were obtained the year that the Monkland line was opened for the Ballochney, in reality an extension of the Monkland and Kirkintilloch, the Dundee and Newtyle, and the Edinburgh and Dalkeith Railways, the

last named of which was opened in 1831. The Garnkirk and Glasgow Railway, authorized in 1826, was opened in 1831 and was worked by both locomotives and horses. This line was 8¼ miles long, and was primarily built for the carriage of coal and iron to Glasgow at St. Rollox from Gartsherrie, where it connected with the Monkland line, taking back Glasgow goods as a return load. The 15-mile Edinburgh and Dalkeith Railway was incorporated in 1826. For part of its mileage it was worked by ropes attached to stationary engines, the remaining mileage being worked by horses for the first fourteen years of its existence, although conveying passengers during that period.

The Dundee and Newtyle distinguished itself by possessing gradients of 1 in 10, 1 in 15, and 1 in 25, on which ropes and stationary engines were used. The Law incline at the Dundee end of the railway appears to have been worked in a similar manner to the inclines used for coal traffic in Durham to-day, where the loaded wagons meet the empty ones on a double line at the central part of the incline. For about two years the stretches of line between the gradients were worked by horse power, but in 1833 steam locomotives began to be employed. The engines are notable as being fitted with a four-wheeled truck or bogie ; thus, they may be regarded as important pioneers of locomotive design. Another interesting feature of this Scottish line was that the gauge was somewhat narrower than the standard gauge to which it was converted in 1849. The line to-day forms parts of the Scottish section of the London, Midland, and Scottish Railway.[1]

In 1831 a line, incorporated in 1825, from Bolton to Leigh was opened, a distance of 9 miles, at an estimated cost of £150,000. Later this was joined to the Liverpool and Manchester by a railway incorporated in 1829 from Leigh Junction to Kenyon, opened June 13th, 1831.

The Leicester and Swannington Railway was opened

[1] The Dundee inclines have been abandoned, since the Lochee Deviation was constructed under the Dundee, Perth, Aberdeen Act of 1859 and opened in 1861.

on July 17th, 1832, with a train headed by Stephenson's locomotive "Comet," and emulated the example of the Canterbury and Whitstable Railway in the possession of a railway tunnel; but in this case the tunnel was provided through necessity rather than the caprice of the promoters. This Glenfield tunnel, about a mile long, proved a difficult engineering task, and asserted its obstinacy by knocking off the "Comet's" chimney on the day of the opening owing to the rails being packed too high at one point in the tunnel by the platelayers. Robert Stephenson was the engineer for this railway, his father having refused owing to pressure of work in connection with the Liverpool and Manchester. The success of the Leicester and Swannington Railway led to the promotion of the Midland Counties line of a later date upon which the first excursion train was destined to run in 1840.

From the Midlands, one has to turn southwards to the county of Murdoch and Trevithick [1] for the opening of the Bodmin and Wadebridge Railway in 1834. Here, once again, mineral wealth is seen developing rail transport, though, in this case, coal cannot claim the honour of being the main cause of its construction. The Bodmin and Wadebridge Railway was part of a larger scheme to connect tidewater at Padstow with the port of Fowey, but built primarily to convey sand in the Bodmin district. Earlier railways existed in Cornwall, namely, the Scorrier and Portreath, and the Redruth and Chacewater which was closed for traffic in 1915; but the Bodmin and Wadebridge was of a more noteworthy type, for it employed steam traction, and on Saturdays carried passengers. The estimated expenditure on this line was £35,000, and perhaps its most important claim to fame is the fact that it forms the oldest part of the London and South Western section of the Southern Railway, though its larger parent possessed no physical connection of its own with the Bodmin and Wadebridge line till a very much later date.

[1] Richard Trevithick (1771–1833) often called "the father of the locomotive engine."

Although this book does not purport to deal with the railways and rail transport conditions in the most recent Dominion of the British Commonwealth, namely Ireland, reference may be made here to the Dublin and Kingstown Railway, the earliest railway of importance in Ireland which was opened in 1834. Constructed at a cost of £50,000 per mile, this line had been authorized in 1831, and was later destined to promote the first atmospheric railway in Ireland, the Kingstown and Dalkey Railway, opened in 1844.

Then ensued a period of intense railway activity. Numerous proposals were put forward in towns all over the country, and many Bills were discussed in Parliament, some of which finally received Royal Assent. The success of the Liverpool and Manchester and the Stockton and Darlington Railways had gripped the imagination of many leaders of industry, though the growing opposition of canal and road interests was rapidly hardening against Stephenson's new form of transportation. Although much construction work was in progress during these two years, no opening of any important railway was actually attained. The London and Birmingham Railway, a line which after a fruitless effort in 1832 had obtained its Act in May, 1833, opened its route to Boxmoor in July, 1837. Similarly the Grand Junction Railway (*vide infra*) was opened in July, 1837. These proved to be the vanguard of many lines becoming available for public traffic during this and the following six years.

Until September, 1838, the southern portion of the London and Birmingham track ended northward at Denbigh Hall, Bletchley. Thence a horse-coach service was run to Rugby, passengers there rejoining the railway for the final part of the journey. The horse-coaches were run by Messrs. Chaplin & Horne, who ran omnibuses also from certain coaching inns in London to Euston Station to connect with the London and Birmingham trains. Some of these inns,—for instance, the Golden Cross at Charing Cross, and the Swan with Two Necks at Lad Lane,—still possess London, Midland, and Scottish col-

lecting offices, which have come down to them through the late London and North Western Railway.

An Act for the Grand Junction Railway, whose most important station was Stafford, was obtained in 1833. At that early date this was a long line, since it consisted of about 80 miles. Its cost was expected to be more than a million and a half. The Act included a curious provision that no practising solicitor should be appointed an officer of this Company. It had been planned to commence southward from the Liverpool and Manchester, which was already in direct rail communication with Warrington by means of a line from Newton, which had reached the former town in 1833. Another line about 6 miles long stretched from Parkside Junction to Wigan. With the Liverpool and Manchester and the Cromford and High Peak Railway, which opened in 1830 and was worked with ropes owing to the long and heavy gradients, the Grand Junction formed part of the erstwhile London and North Western Railway. The Grand Junction Company obtained powers to construct a railway from Warrington southwards to Birmingham,—at its northern end it absorbed the Warrington and Newton in 1835, and at the southern end it would connect with the proposed London and Birmingham, a line expected to be 111 miles long [1] and estimated to cost £4,500,000. Together, then, this £6,000,000 scheme was to join London and Lancashire by rail. It was destined later to become the main line of the Southern Division of the London and North Western Railway, though this latter main route was subsequently shortened between Rugby and Stafford by the Trent Valley Railway which passed Birmingham, leaving it aside to the west. Old maps reveal how comparatively unimportant was Rugby, despite the famous Elizabethan school. The town, thirteen years after the opening of the railway, possessed a considerably smaller population than that of Daventry near by.

The opposition of the canal interests which centred on Birmingham at that time, as they may almost be said to do to-day, was very strong. Little assistance for these

[1] As finally built the line was 112½ miles long.

railways was forthcoming from landowners and the towns which later on were to benefit so enormously from railway facilities. Although the London and Birmingham's engineering difficulties, notably Kilsby Tunnel costing more than three times what had been estimated, were very much greater than those of any previous railway, it has been maintained that the Company's capital warrant was increased by about £500,000 through having to conciliate the opponents of the Bill. Here, again, the future progress of this country was heavily mortgaged by the shortsighted policy of our ancestors in the early nineteenth century. Smiles tells of a reverend gentleman that it was only when he was in the pulpit that the surveyors could work on his land, "the surveyors concluding the task as he concluded his sermon." [1]

The northern partner of the London and Birmingham, namely the Grand Junction Railway, appears to have requited clerical attacks on the former by inserting a clause in its Act of 1835 providing that "no ecclesiastical person shall be capable of acting as a Director or otherwise in the management of the affairs of the Company."

It was the trading interests of the towns which launched all these large early railway schemes: the opposition to them came very largely from agricultural interests represented by landowners and farmers. The fright caused to livestock on seeing a locomotive which emitted steam and smoke, and the damage done to game preserves, seem to have been the two chief grounds alleged in opposition to the early railway promoters. The opposition of canal interests to railways is natural and easy to explain, but it is difficult to see why agricultural interests did not realize the value of a railway service almost as soon as the traders in the towns.

The Coventry and Oxford routes between London and Birmingham were both considered by Stephenson, who finally decided on the former, although meetings of opposition were held at Towcester, Leighton Buzzard, Watford, and even in London itself. At most of these meetings, the entire adequacy of coach transport at 10

[1] *The Story of the Life of George Stephenson,* Samuel Smiles.

miles per hour for passengers and a surplus of canal facilities for freight traffic was stressed with vehemence. The Bill, after being rejected by the House of Lords in 1832, finally passed both Houses the following year, after the opponents of the Bill had been conciliated. Parliamentary expenses for the Bill are said to have cost £72,868.

The work of construction of the Grand Junction was let out on contract, and while Locke was the engineer for the line, Thomas Brassey obtained his first contract for railway construction. The Grand Junction proper was opened for traffic throughout on July 4th, 1837. The Grand Junction absorbed the Liverpool and Manchester, and the Bolton and Leigh a few years later, as well as its younger and much smaller sisters, the Chester and Crewe, the North Union, and the Manchester–Crewe line of the Manchester and Birmingham. Thus, upon amalgamation with the London and Birmingham in 1846 the formation of the London and North-Western route from Euston became an accomplished fact.

Another line was opened in the north of England in 1834, between Leeds and Selby, thus substituting 20 miles of rail for 30 miles of canal. The Company was formed in 1829 and met strong opposition from the Aire and Calder Navigation Company ; nevertheless, the Act authorizing its construction was passed in May, 1830, with the power to raise capital to the extent of £300,000. Within a year of its opening in September, 1834, this railway had in operation combined rail and water transport passenger fares between Leeds and Hull and combined rail and road fares between Leeds and York, both through Selby.

The Greenwich Railway [1] is an interesting line since, for many years, its trains ran on the right-hand instead of on the left-hand set of rails. In 1837 London saw its first passenger steam railway with a terminus south of the Thames, namely that of the above Railway opened from Southwark to Deptford on December 14th ;

[1] An Act for this railway received Royal Assent on May 17th, 1833.

the line was opened for its whole length in 1839. London Bridge station of to-day stands on the site of the old Southwark terminus, while the arches, 878 in number, for letting which the railway promoters expected to obtain considerable revenue, still stand much as they did when the first load of passengers travelled through Spa Road to Deptford. To-day this line, like the Canterbury and Whitstable, forms part of the South Eastern section of the Southern Railway.

Another early line was the Manchester and Bolton Railway. The good citizens of Southern Lancashire, who aided Stephenson so considerably with the London and Birmingham scheme, seem to have taken enthusiastically to railway promotion during the thirties, so that it is not surprising that Lancashire was once again to witness the opening of an important line, destined thus early to be one of the ancestors of the Lancashire and Yorkshire Railway of recent times. This was the Manchester, Bolton, and Bury Canal Navigation and Railway, upon which it was expected to spend £300,000. This scheme is of considerable interest, as it was one of the first cases where a railway was proposed which should take the place of the canal. The Act of 1831 which authorized the construction of the line permitted the railway to be built either on the site of the canal itself or upon the side of the canal. The line actually cost about £60,000 per mile, or roughly double the original estimate. This line was opened in 1838. Alexander Nimmo, a Fellow of the Royal Society, and one of the supporters of the Liverpool and Manchester Railway, was engaged on this work, as also on the Manchester and Leeds to be opened in 1841.

The 23rd May, 1838, saw the opening of the earliest part of an 80-mile railway from London to Southampton, expected to cost a million and a half. This was the section from Nine Elms, the early London terminus of the line, to Woking, upon which a service of five trains in each direction daily was provided. The next year saw the line opened to Basingstoke from Woking, and also between Winchester and Southampton, the intervening mileage

being covered by coach. Even at the present time, there is only one intermediate station on the $18\frac{3}{4}$ miles stretch from Winchester to Basingstoke. In May, 1840, trains ran between London and Southampton for the first time. Unlike so many of the northern railways, this line was not built because of any adjacent rich mineral district. The main incentive for its construction seems to have been the desire to make use of the tidal advantages which Southampton possessed over many other harbours, although the possibility of foreign interference with the coasting trade between London and Southampton—a remnant, no doubt, of the feeling engendered by the long-drawn-out Napoleonic Wars—was also an added incentive. Doubtless, the shipping men of Southampton were inspired by the enterprise shown by Liverpool in regard to the Liverpool and Manchester Railway. A prospectus of the Southampton, London, and Branch Railway and Dock Company was published in 1831. Financial difficulties retarded the scheme, but after the passing of the London and Southampton Railway Act in 1835, the Southampton Dock Company came into existence in 1836, and ever since this connection between the Dock Company and the railway has been of the closest.

The railway appears to have cost about £200,000 more than the original estimate, but when compared with such lines as the London and Birmingham, this excess is comparatively small. The engineer in charge, Francis Giles, appears to have had in mind, to the annoyance of the Great Western promoters, a branch to Bristol, and this may explain his choice of the Basingstoke route, though the avoidance of tunnel-making up to the Winchester district may have carried weight in his choice. Once more Lancashire appears to have shared in this railway promotion, for when progress was too slow, the Liverpool interest was powerful enough to replace Giles by Joseph Locke of Grand Junction fame, and a close friend of Stephenson. Locke, in turn, contracted the last section to be opened to Brassey, who completed it. To its efficiency the country has owed much in times of crisis. From the first, this line has had a military implication, just as

it had a close relationship with dock working, and less than two years after its opening from London to Southampton, a branch was completed from Bishopstoke, now Eastleigh, to Gosport, thus attaining the naval character which is always associated with the line serving the southern naval bases of Portsmouth, Plymouth, and Portland. In 1839 the railway became known as the London and South Western, whose growth will be traced in the succeeding chapter.

Less than three weeks after the opening of the first section of the standard gauge London and Southampton, there was opened the first important section of its rival, the broad-gauge Great Western. The adjective "important" is used advisedly, since the Stratford and Moreton tramway was opened for traffic in 1826, constructed to standard gauge, a branch being later constructed to Shipston-on-Stour. Worked by horse-power, a passenger service was at one time run, but was not a financial success. Since absorption by the Great Western Railway a passenger service has been run over the reconstructed portion between Moreton and Shipston; the only part of the remaining portion visible is the stone blocks upon which the old rails rested until required for munition purposes in the recent war.

Just as the people of Southampton had been encouraged in their railway venture by the extra trade brought to Liverpool by reason of the Liverpool and Manchester Railway, and had later obtained help from the Liverpool believers in rail transport for carrying out their rail project, so likewise the home of the Merchant Adventurers also reached the conclusion that the trade of their city of Bristol would be considerably assisted by rail communication with the capital. Difficulties of water communication between the Thames and the Avon were considerable and ordinary road transit was uncertain and expensive, with the result that as early as 1825 there was an agitation to improve the communication between Bristol and London. The success of the Liverpool and Manchester gave a final impetus to the formation of a Bristol and London Railway.

The son of the designer of the Thames Tunnel, Isambard Kingdom Brunel (1806–1859), who had designed the Clifton Suspension Bridge in 1831, was appointed engineer, and under the name of the Great Western Railway, the only early railway to retain its original title unchanged to the present day, a Bill was passed in 1835, by which lines commencing at each terminal would eventually unite Bristol with London. No gauge was mentioned in the successful Bill, though 4ft. 8½ins. had been mentioned in a previously unsuccessful one. As a result of Brunel's desire for a 7-foot gauge which would allow the wheels to remain outside the body of the vehicle instead of underneath it, England was destined to witness the so-called "battle of the gauges," between Brunel's broad gauge of 7 feet, and Stephenson's 4ft. 8½in. so-called narrow gauge. By those who regret the final conquest of the latter it should be remembered that it is less the rail than the loading gauge, that is, width and height of vehicles, which determines the existing size of our carriages and freight wagons. Stephenson in the twenties had seen the necessity for a uniform gauge, and had imposed his will on all the early promoters, however far apart their lines might then lie. Brunel, to save his western counties from rival companies, adopted a wide gauge of his own. It is fair to say that Stephenson's gauge is to-day predominant, though various gauges still exist in Australia, India, South America, and Africa.

A provision of the Great Western Railway's Act forbade the railway's approaching within 3 miles of Eton College, except with the consent of the Provost and Fellows. The Railway Company had further to provide sufficient staff for preventing access of Eton boys to the railway, the Headmaster and Provost being given the power of dismissing that staff if inefficient in this respect. Not until forty years later were these special appointments abolished by mutual consent.

The year 1841 saw the completion of the railway between Bristol and London, though the present Paddington Station was not opened until 1854, Bishop's Road having been used previously. Although known as the

Great Western, the history of its origin is clear from its arms, consisting of those of London and Bristol. It is curious that once again the initiative for the line's construction came from a provincial city and not from the capital, and that on reaching the capital it was not permitted to obtain a home nearer than Paddington, said to have been green fields at that date. How great London's gain to-day if the railways had been permitted to enter further towards the centre of what is now all one large city.

The Great Western system of to-day is roughly of triangular shape with apices at London, Chester, and Penzance, over the greater part of which area it possesses rail monopoly control ; if one bisects the angle at London, the resulting line will not be far from coincident with the present London to Bristol line, through Bath, which formed the root from which the great tree grew, not only in size but also in progress and efficiency. For many years its speed records have made it world-famous, but its later history is to be treated in a succeeding chapter.

The year 1838 saw not only the opening of the Great Western's rival to the south, but also witnessed the opening of what was to be its great rival on its north-east flank, for the London and Birmingham was opened throughout in the autumn of that year.

June, 1839, brought the opening of the London and Croydon Railway south of the Thames, and a wider gauge line known as the Eastern Counties, which was destined later to form part of the Great Eastern system. The first-named of these two lines was promoted to take the place of the Croydon Canal authorized in 1801 for about £40,000, which ran from near the present London Bridge Station to where West Croydon now stands, a distance of $8\frac{3}{4}$ miles. Owing to its unsatisfactory nature with numerous locks which were required to effect a crossing of Forest Hill, the London and Croydon Railway bought it up, using what parts of its land they were able for the purpose of their railway. Though the London and Croydon line possessed the land of the canal of that name, they ran into London Bridge Station over the London and

Greenwich from Corbett's Lane Junction, a distance of $1\frac{3}{4}$ miles. This London and Croydon line proved to be the nucleus of the London, Brighton, and South Coast section of the Southern Railway, for the London and Brighton, in obtaining their Bill in 1837, were forced to give up the northern mileage of their line between Kennington and Croydon, which had been planned by John Rennie, as it would have competed with the London and Croydon, at that date not completed. Their Bill, therefore, provided for a line from Croydon to Brighton and, at the same time, forced them to buy up the previously mentioned extension of the Surrey Iron Railway, some remains of which in the form of stone-sleepers were visible near the Brighton main road not far from Purley a few years ago.

The Eastern Counties Railway from London to Chelmsford, Ipswich, Colchester, and Norwich, has probably one of the longest railway mileages of any railway contemplated by any one Act of Parliament, for this line was to be over 126 miles long, thus making it 10 miles longer than the London and Bristol (Great Western) Railway and 13 miles longer than the London–Birmingham ; but the estimated expenditure of the Eastern Counties—namely, £1,500,000—was only 33 per cent. of that of the London–Birmingham.

Such is the story of the start of the railway industry in Britain. It will have been seen that these early lines may be said to have had their origin in the coal-fields, and were evolved from the much earlier horse-hauled plate and stone ways. Looking back over a century of progress, one or two features of early railway history stand out forcibly, namely, the manner in which the capital city played so little a part in early railway history, no doubt because it was far removed from important mineral areas. Tyneside and Merseyside may justly point with pride to the part both these areas played with regard to railway promotion. Railways tended to stretch towards London, rather than from London, though when the success of the Liverpool and Manchester, and the Stockton and Darlington had been proved there are several instances where

lines under construction to or from London were completed at either end with a coach journey of some miles joining the two sections. Bradshaw's Railway Time-table first appeared towards the end of 1839.

The foresight of George Stephenson stands out, especially in his advice to adopt a standard gauge; for this the industry owes him much, but to him also praise is due for his prophecy as to the boon of cheapness of rail travel for the less well remunerated workers. These two principles for which he fought so hard form the first two principles of railway economics, namely, the aim of through working, or long hauls, and low rates and fares.

On the other hand, it is matter for remark that the possibility ever arising of London having to deal with through traffic in large quantities never seems to have been realized. Terminals were built in what were then green fields and few considered the necessity of through stations to join railways on the two sides of the Thames.

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CHAPTER III

THE EVOLUTION OF THE BRITISH RAILWAY SYSTEM

THE SOUTHERN RAILWAY. 1840–1927

In the last chapter the early railways of Great Britain were dealt with chronologically in the order of their opening, and by 1840, with one or two exceptions, there were open for traffic the small lines which were destined in later years to form the nuclei of all the large systems whose names were bywords throughout England prior to the Act of 1921, which then grouped them into four large companies.

From 1840 through the three next following decades many lines were opened throughout the country, and it will perhaps be more convenient if, from that year onwards, we trace the growth of the four well-known systems which exist to-day. To deal with each opening chronologically would necessitate continual shift from one area of the country to another, and would permit no clear view of the characteristics developed by each line, or comprehension of the local needs which each endeavoured to satisfy. We shall commence south-east of London and work round in a clockwise direction without regard to any importance of the individual railways.

The South Eastern and Chatham Railway

We set out then with the evolution of this line from 1840 to 1927. The South Eastern and Chatham was operated as a single railway by a Managing Committee representing the London, Chatham, and Dover Railway, and the South Eastern Railway.

By 1840 the Canterbury and Whitstable line had been open for traffic for ten years, and the Greenwich Railway for four years. The London and Dover line of the South Eastern Railway which was authorized in 1836 was originally planned to run through Oxted. The line was diverted so as to run through Redhill in order to save expenditure, and was opened from Redhill to Dover in February, 1844. Thus there became available for passenger traffic a railway route to the Channel ports for the French and Belgian coasts. Between Norwood and Redhill the line was used jointly by the South Eastern and London and Brighton Railways for many years; and it was only comparatively recently, in 1900, that the London, Brighton, and South Coast Railway, as successor to the London and Brighton, had completed their own line avoiding Redhill, though some of their trains still continued to use the old line after that date. This route, which forms two sides of a triangle, was adopted partly owing to the opposition of the people of Maidstone to a project of a railway in Central and North Kent, which line would have joined their town westwards to London and eastwards to Dover, and partly owing to fear of inability to compete successfully "with a parallel steam navigation." [1] Maidstone adhered to water traffic, and, as a result, the Ashford passengers travelled by way of Redhill, on the London side of which they travelled over some of the mileage of the Brighton, London and Croydon, and Greenwich Railways; it is noteworthy that the then Speaker of the House of Commons intimated very strongly that no second outlet would be permitted to the south. The line was opened to Folkestone in 1843 and to Dover in 1844, though the Company only became carriers on February 1st, 1845. William Cubitt (1785–1861), who had been appointed engineer, had found it possible to make the line from Redhill through Tonbridge and Ashford ideally straight with easy gradients, but the stretch between the two coast towns provided many difficulties. Apparently

[1] *S.E.R. General Statement of the Position and the Projects of the Company*, 1845–6.

the trains between Dover and Folkestone in early days ran on the right-hand set of rails, if an old reproduction in the *Illustrated London News* of 1846 gives us a true picture of a train emerging from the Bletchingley Tunnel.

The directors, in spite of financial difficulties which appear to have beset the line from its incorporation, seem to have anticipated considerable traffic, as no less than seventy locomotives were ordered during the financial year 1844–1845. In 1845 the Gravesend and Rochester Railway was opened and was worked by the South Eastern Railway from 1847.

A new London terminus, namely Bricklayers' Arms, with its connecting branch costing £250,000, was opened in 1844 and was later honoured by the arrival there in 1863 of Queen Alexandra, when she first came to London as H.R.H. Princess Alexandra of Denmark. This year saw the first series of leasings and amalgamations of importance, and the South Eastern can offer examples of this important change in railway policy ; the Canterbury and Whitstable was leased by the South Eastern in 1844, though not finally bought by the latter until 1853. The London and Greenwich was also taken over on a long lease in 1845, while the neighbouring London and Brighton absorbed the London and Croydon. By 1845 £4,500,000 had been spent on the line, and in 1846 the South Eastern Railway was authorized to build the North Kent line running through Woolwich and Dartford to Gravesend, where a junction was to be made with the hitherto isolated Gravesend and Rochester Railway. This connecting link was opened in 1849 and was extended from Stroud to Maidstone in 1856, where it made connection with the earlier branch from Paddock Wood on the Redhill to Dover line. The branch from Ashford on this last-mentioned line was opened to Canterbury, where it linked up with the Canterbury and Whitstable, in February, 1846, and to Ramsgate and Margate later in the same year. Seventeen years later the rival London, Chatham, and Dover opened a much shorter route from London to these two coast towns. A branch from Ashford to Hastings and St. Leonards was opened in 1851, but the

shorter line from London by 20 miles through Tunbridge Wells was not opened until 1852.

By 1857 the South Eastern possessed a track mileage of 266 miles. The fact is stressed by the early directors that the line was never known as the London and Dover, but always as the South Eastern, and therefore it is not surprising that the later forties should see branches growing northwards and southwards from the main London and Dover trunk to Canterbury, Ramsgate, Sandwich, Minster, and Deal, in the East Kent area, and westwards from Redhill through Guildford to Reading,[1] where traffic could be transhipped to the broad-gauge Great Western.

The early fifties saw the rise of its great rival, the London, Chatham, and Dover, which was zealously backed by Crampton, of locomotive fame, from small beginnings in 1853 as the East Kent Railway. This East Kent line, opened from Strood to Faversham, gradually extended along the northern Kentish coast, and reached Dover in 1861. As no railway existed at Calais when the South Eastern had first been opened, this line had based its cross-Channel services upon the Folkestone and Boulogne route, whilst later the London, Chatham, and Dover was eager to run trains in connection with the rival boats from Dover to Calais, which by this time was served by rail. It is beyond question that the delay of railway construction in France caused the South Eastern considerable financial difficulty during the first ten years of its existence. By means of the Mid-Kent line extension to St. Mary Cray, its enterprising rival, the London, Chatham, and Dover, passing through St. Mary Cray, Bickley, and Penge, finally made its London termini at Victoria, opened temporarily in 1861, Ludgate Hill in 1864, Holborn Viaduct in 1874, and St. Paul's in 1886,

[1] This line was built as the Reading, Guildford, and Reigate Railway in 1849, with a capital of £800,000, and absorbed by the S.E.R. in 1852. As early as 1844, the S.E.R. directors claimed that this important east and west link would prove useful in the connections then being planned for German and Mediterranean lines.

that extraordinary combination of three separate, comparatively small, stations within about a quarter of a mile of one another. In answer the South Eastern opened Charing Cross in 1864, and had reached Cannon Street two years later.

Financially unsound and relying mainly on a competitive passenger traffic, the London, Chatham, and Dover was built piecemeal, at as little expense as possible. It covered country of considerable undulation, and the track consisted largely of a series of curves, often built in tunnels over a switchback route of fairly steep gradients ; it probably provided the most difficult railway operating problems of any line running out of London. During the sixties and seventies short but important extensions were made to the South Eastern Railway in the London area. A much shorter route to Dover and Hastings than that through Redhill was built by the South Eastern in 1868, joining the old route at Tonbridge. Its gradients are heavy and include a long tunnel at Sevenoaks, but it succeeded in saving 13 miles on the distance to Dover, and placed both railways in a position of approximate equality as to distance.

The story of the cut-throat competition between these two lines is one of great interest to the railway student, but it is a story by itself and would be out of place here. Its main importance, from the economic standpoint, is that it demonstrates, probably better than any other case in England, that the final stage of all violent railway competition must be amalgamation or at any rate a close working agreement. The overhead or fixed costs of railway operation form too large a percentage of the total for strong rivalry to last for any great period of years, unless fares and rates can be raised to a height which will yield a surplus to both lines. This must be done, however, without by so doing impairing very greatly the volume of traffic. With efficient road, water, or air competition such a hypothetical position is difficult to conceive.

The inevitable agreement for the setting up of a joint South Eastern and Chatham Managing Committee took

place in 1899, at which date the London, Chatham, and Dover comprised a system of about 200 miles. Since then active competition has ceased and endeavours have been made to utilize to the best advantage the duplicate mileage which former competition had saddled on the Managing Committee. The construction of the Bickley–Orpington connecting lines, completed in 1902, eased many of the traffic difficulties. The South Eastern and Chatham section of the Southern possesses about sixty possible routes from Charing Cross to Dover, and even more from others of their London termini.

Considerable improvement was made in the services offered between 1900 and 1914, but for the following five years of war a tremendous strain was thrown on this line, serving as it did the eastern Channel ports ; and with the uncertain position of the post-war period, it was left to the present Southern Railway to carry out the long deferred programme of bringing this eastern section of its line up to the best British standard practice. Its traffic has always been of a special nature, consisting as it does largely of boat-train services, liable to be interrupted by foggy weather and Continental train services beyond its control. Possessing no rich manufacturing district in its area outside the metropolis, where hauls are short, expensive, and difficult to carry out, it has to rely mainly on agricultural products, much of which, like fruit, necessitates a fast and punctual service to London, coupled with the added difficulty of careful handling. What coal it carries must bear an empty haulage back to London, though in the near future it is possible that the Eastern Section of this railway may become a very important coal carrier. In the London area its suburban trains suffer from omnibus, tramway, and tube competition. It has developed a lucrative excursion traffic to Kent coast resorts, which all the devices of unregulated motor coach competition appear to be unable to wrest from it.

During the first year of operation the South Eastern carried 100,000 tons of goods, while in the last quarter of 1844, 209,932 persons were carried, a similar period a

year later showing an increase of nearly 90,000, a result of one of the earliest cases of a drastic reduction of fares, the average amount per person being 5*s*. 2*d*. in 1844, and 3*s*. 8*d*. in 1845. At the latter date the South Eastern was carrying third-class passengers at a higher rate of speed than any other line south of Lancashire. No less than twelve trains conveyed third-class passengers, while the London and Birmingham then had only two. Moreover the South Eastern fare was considerably below 1*d*. per mile.

Table I, p. 48, gives a general impression of the growth of the South Eastern and London, Chatham, and Dover Railways.

The London, Brighton, and South Coast Railway

After the South Eastern and Chatham Railway, its near neighbour, the London, Brighton, and South Coast Railway, is the next line to invite study. Although the Surrey Iron Railway of 1801 was situated in the area lately served by the London, Brighton, and South Coast, now also part of the Southern System, the London and Croydon Railway from Corbett's Lane Junction to West Croydon may be regarded as the first section around which the system gradually grew.

Owing to the popularity of Brighton as a health resort, frequented by royalty from about 1790, it is not surprising that numerous projects were afoot in the early days of the railway era to join it to London by rail, though the famous coaches which were accustomed to cover the distance of about 50 miles in under the five hours must have offered a strong competition to passenger rail transport.

Several plans were put forward and routes suggested, but nearly all may be said to have followed one of two routes : firstly, those—amongst which was Stephenson's—running through Shoreham, Horsham, and Leatherhead, terminating with the proposed London and Southampton near Vauxhall ; or, secondly, those—amongst which was Rennie's—commencing with the route of the London and Croydon Railway, then following the Surrey Iron Railway's route to Merstham, after which the line made straight for Brighton. The latter was a shorter but more

difficult route from the engineering point of view. After several attempts Rennie's direct line, embodied in the London and Brighton Railway Act, received the Royal Assent in July, 1837. The law charges alone averaged £3,400 per mile, and in addition tolls had to be paid to the London and Croydon, and London and Greenwich Railways, over whose lines the trains to and from Brighton were to run in order to obtain access to the terminus at London Bridge. Finally, as was mentioned in connection with the historical outline of the South Eastern Railway, the latter was to be given the southern half of the Norwood to Redhill section on payment of a sum of £340,000.

Rastrick (1781–1856) was the engineer responsible for the construction of the line, and a fitting memorial to him exists to-day in the magnificent viaduct over the Ouse between Hayward's Heath and Balcombe. Heavy tunnelling was incurred at Clayton, 2,288 yards long, where the South Downs are met, and at Merstham, 1,122 yards long, where the North Downs are cut through. The line was opened through to Brighton in September, 1841, after a period during which, like its most westerly neighbour, the uncompleted section had been covered by a coach service.

In the following year the first-class mail train was scheduled to take two hours over the 50-mile journey, and the mixed trains two and a half hours. The line appears to have earned good revenues from the first and took over the London and Croydon in 1846, taking the name of the London, Brighton, and South Coast. In 1845 the London and Croydon had experimented with the atmospheric system of propulsion between Forest Hill and West Croydon, but finding it unsuccessful had quickly discarded it. A branch had been opened in 1840 to Shoreham from Brighton even before the main line had been completed, and it was not long before further branches to other coast towns followed. Westwards, by means of subsidiary companies subsequently taken over, the line reached Portsmouth Town and Cosham by 1848, and eastwards to Lewes and St. Leonards in 1846.

By running powers over the South Eastern, entry was

made into Hastings in 1852, through the Bo-Peep tunnel,[1] which is unique in that while possessing a double line it can only be worked as if it were single owing to its narrow loading gauge. For many years the time-tables made no allowance for this Board of Trade regulation and trains were timed to cross one another in the tunnel. Even to-day the tunnel restricts the size of the rolling stock on the Hastings services. Until the opening of the South Eastern's Sevenoaks route to Tonbridge in 1868, the London, Brighton, and South Coast and the South Eastern divided the London and Hastings traffic. In 1847 the Wivelsfield to Lewes cut-off line was completed, as well as the branch to Newhaven, whence the packet service to France started in 1849, the year which also saw the opening of the Hailsham, Eastbourne, and Deptford Wharf branches.

West of the main line the railway from Three Bridges to Horsham was opened in 1848, and though this branch extended to Petworth in 1859, it did not effect any junction with the coast line at Ford for another fifteen years. In 1847 a line, long projected by the London and Croydon, had been opened from the latter place to Epsom, and extended to Leatherhead in 1859, though the intervening gap between Leatherhead and Horsham was not completed until 1867, two years after the opening of the Guildford branch from Horsham. By 1857 the time taken by the fastest train between Brighton and London had been reduced to 65 minutes.

[1] Extract from Appendix to Working Time-table, South Eastern and Chatham Railway, dated May, 1922.

"BO-PEEP.—Notice to Signalmen of working trains through Bo-peep Tunnel.—S.E. & C. Passenger trains as well as S.E. & C. or L.B. & S.C. Light Engines are allowed to pass each other in Bo-peep Tunnel.

"A Light Engine must not be allowed to pass a Goods Train of either Co., or a L.B. & S.C. Passenger Train in this Tunnel. In the case of all other classes of Trains, the Signalman at Bo-peep Junction, St. Leonards (W.S.) and Hastings West Yard Cabins, must so regulate the Traffic so that not more than one Train may be allowed in the Tunnel at the same time."

An important event in the history of the line was its entrance into the West End of London through Clapham and Battersea. The terminus at Battersea was opened in March, 1858, by the West End of London and Crystal Palace Railway, incorporated in 1853.[1] By means of the Victoria Station and Pimlico Railway the L.B. & S.C. was then extended across the river and reaching Pimlico became installed into its present terminus at Victoria in October, 1860.

Other lines have since been added at later dates, such as the branch from Lewes to Uckfield, opened in 1858, extended to Groombridge in 1868, and in its triangular territory between Portsmouth, Hastings, Tunbridge Wells, and London, except at these boundary towns and at Redhill, it enjoyed a fairly complete railway monopoly outside the suburban area.

Almost purely a passenger line from its inception, its freight traffic consisted of local agricultural produce, fruit from West Sussex, a cross-Channel trade through Newhaven, and a reception of coal from the northern lines to the southern coast towns. This is a traffic which, like that of its eastern neighbour, involves a long return haul of empty wagons. What freight traffic exists then is of a very short-haul nature, as is its passenger traffic, which it has developed very successfully. Possessing City and West End termini in London, it has four tracks from each of these to Croydon, and four tracks as far as Balcombe Tunnel, 31¾ miles distant from London on the main line to Brighton, in addition to possessing various alternative routes to Eastbourne, Brighton, and Portsmouth. As mentioned in connection with the South Eastern Railway, the Redhill avoiding line opened by the London, Brighton, and South Coast Railway in 1900 revolutionized the main line train services and their punctuality.

The earliest big railway in the south of England to electrify part of its suburban line, it has succeeded in retaining its suburban traffic in spite of strong competition from omnibuses, tramways, and in a lesser degree the

[1] The Crystal Palace itself was opened at Sydenham in June, 1854.

City Tube. With such density of traffic in the London area, it has never been noted for speed, largely owing to its heavily graded lines, and numerous junctions in the London area, but the frequency of its service has brought to it much season ticket traffic, an added attraction being the beauty of the country through which the line passes. The problem of rush hour traffic and summer week-end holiday traffic, which latter depends largely upon the vagaries of the English climate, have formed the main operating problems of the line. These coupled with the short distance of its non-stop runs have been the cause of its lack of vestibuled passenger carriages, a paucity of which is to a certain extent made good by the inclusion of many extra fare Pullman cars in its express trains. One would have expected that road competition would have been felt more severely by this line than by almost any other in Great Britain, but the still growing popularity of its coast towns appears to have made up for much of the traffic which it has lost to the road.

A small London line, with a route mileage of only 7 miles, always closely connected with the London, Brighton, and South Coast Railway, and which has been acquired by the Southern Railway since the latter's formation, is perhaps worthy of passing notice, since it forms an important link between the lines north and south of the Thames. The construction of the East London was authorized by an Act of 1865, and the railway ran from a junction with the Great Eastern at Bishopsgate to the New Cross Stations of the erstwhile London, Brighton, and South Coast, and the South Eastern and Chatham Railways. To pass underneath the Thames, the East London used the tunnel which Sir M. I. Brunel, the father of I. K. Brunel of Great Western fame, completed in 1843. This tunnel had taken no less than eighteen years to complete.

The line was opened throughout in 1876, and for some years trains were operated to and from Liverpool Street Station by the London, Brighton, and South Coast, but in 1880 the South Eastern also commenced to run trains over the line into Liverpool Street. Four years later, it

was decided to connect the line at Whitechapel to the Metropolitan and District Railways, and the line was leased to no less than six railways—the London, Brighton, and South Coast, the Great Eastern, the South Eastern, the London, Chatham, and Dover, the Metropolitan, and the District Railways. For several years the Great Eastern, Metropolitan, and District Railways worked train services on the line.

Never financially strong, the Company was forced to protect its revenue by electrification in 1913, so that through working with the Metropolitan and District Railways, which had converted their own lines to electric traction in 1905 and 1906, might again take place. When the new electric services began in 1913, the Great Eastern withdrew their passenger steam trains, and the traffic and revenue steadily increased as a result of the through and more frequent train services. The line, in addition, however, forms a valuable link in freight train services which were worked by the Great Eastern, although the lay-out at Spitalfields, near Bishopsgate, involving the use of a hoist, places a strict limit on the amount of traffic which can be handled.

Table I, p. 49, is sufficient to give a general impression of the growth of the London, Brighton, and South Coast Railway over a period of sixty years.

London and South Western Railway

By 1840, as has been noted in the previous chapter, the London and South Western Railway had become firmly entrenched in the Southampton area, but its western terminus was still many miles distant from the Bodmin and Wadebridge. This small Cornish line, which had been opened in 1834, now forms the oldest part of the London and South Western section of the Southern, being absorbed in 1845 at a cost of £35,000, to prevent it from falling into the hands of the Cornwall Railway, which was controlled by the Great Western and its associates. It had been intended in the early forties that the Bodmin and Wadebridge should form a link in the Cornwall and Devon Central Railway from Exeter to

Falmouth. This scheme, however, failed to materialize. The Bodmin and Wadebridge was an isolated fragment of line until 1887, when it became connected with the G.W. branch to Bodmin, but it was not until 1895 that the North Cornwall line of the London and South Western reached Wadebridge.

The docks at Southampton grew steadily, though not nearly as fast as the railway grew. As early as 1842, Southampton was the headquarters of the Royal Mail Steam Packet Company. During the same year the Peninsular and Oriental mail ships discharged at the port, and three years later the Weymouth Channel Islands steam packet service was diverted to Southampton. As the railway brought traffic to the port from its increasing hinterland, so the port fed the railway with valuable traffic, often requiring a speedy service for transport to the metropolis.

After the opening of the Gosport line in 1842, the next important main line extension was that to Dorchester through Ringwood in June, 1847, though branches had meanwhile been opened to Guildford and Richmond in the London section. The following years saw further developments, notably the opening of the new terminus at Waterloo in 1848, the change from Nine Elms costing over £700,000 for a length of less than 3 miles. The same year saw the line's entry into Portsmouth by way of Cosham. As a result of the extensions of 1848 the dividend fell the following year from 8 per cent. to 3 per cent. The new Waterloo Station completed since the war deals with about 150,000 passengers each week day.

Little main line extension took place from 1848 until 1854, which saw the opening of the broad-gauge North Devon line, originally known as the Taw Vale, to Barnstaple, and the extension from Basingstoke to Andover. Powers had been obtained as early as 1844 for the Basingstoke to Salisbury line, but the financial panic of 1847 had delayed the work very considerably ; thus Salisbury was reached first from Eastleigh, then called Bishopstoke, in 1847. The London and Salisbury direct line was not opened until May, 1857.

The Reading branch was opened for traffic in 1856, and the strenuous battle for entry into Portsmouth through Havant took place in 1858, when the Brighton Company successfully prevented the London and South Western Railway train from passing through by removing the junction rails and chaining a locomotive to the crossing. After an agreement, reached, however, as a result of legal action, both railways used the Havant to Portsmouth line from 1859 onwards, and in later years a pooling agreement, allotting two-thirds of the London–Portsmouth traffic to the London and South Western Railway, was arranged.

Exeter was reached in 1860 by way of Sherborne and Yeovil, by an Act obtained in 1856 ; the line immediately to the west of Salisbury being known as the Salisbury and Yeovil, incorporated by an Act of 1854 and opened throughout in 1860. This railway managed to pay dividends of 14 per cent., in spite of a heavily graded line, before the London and South Western Railway directors exercised their power, obtained by early financial aid, of absorbing the line. The Crediton and Barnstaple lines are of interest because, being of broad gauge, the London and South Western had to convert them to narrow gauge in 1863 though a mixed gauge remained until 1872. The Exeter and Crediton, $5\frac{3}{4}$ miles long, with a capital of £70,000, and the Crediton and Barnstaple being broad-gauge lines had been backed by the Great Western in their promotion in 1845.

Bournemouth may be regarded as one of those cities built up almost entirely by railway transport. It was not until 1862 that Christchurch was reached by a southerly branch from Ringwood, extended in 1870 to Bournemouth ; previously passengers arrived by road from the nearest railway station at Hamworthy. In 1861 the population of Bournemouth is given in the census for that year as about 1,700, and by the 1881 census as ten times as great.

The Andover and Redbridge Railway, amalgamated with the London and South Western Railway in 1863, two years before its completion, is important as, round it, swayed a battle of the rival broad and narrow gauges.

As early as 1847 the London and South Western, to keep the Great Western broad-gauge line from Southampton, had proposed to take over the Andover and Redbridge Canal, built in 1790, but 1847 was a year of reaction resulting from the railway mania of 1844, and the scheme was dropped.

Okehampton was reached in 1867 and Ilfracombe in 1874, while the Guildford new line, opened in 1885, and the Bournemouth direct line, opened in 1888 through Brockenhurst, revolutionized the train services in those two districts and gave the London and South Western a chance of obtaining important added traffic through the growth of Bournemouth. For some years the London and South Western Plymouth trains entered that town over Great Western metals from Lydford, by means of a mixed-gauge line through Tavistock and Yelverton ; but in 1890 the Plymouth, Devonport, and South Western Junction opened a line reaching Plymouth through Devonport, the London and South Western Railway operating the trains on this railway. The railway reached its westernmost point, Padstow, in 1899.

From early days the London and South Western has been financially profitable, and in the forties the operating ratio, that is to say the operating cost in relation to the gross operating revenue, was as low as 43 per cent., a great contrast to the figures of to-day, when 80 per cent. and 85 per cent. are common. For the first forty-four years of its existence this railway never paid less than 3 per cent. as a dividend, and averaged $5\frac{1}{4}$ per cent. over the whole of this period.

An interesting group of three small railways now forming part of the Southern System was that situated in the Isle of Wight. The first section of track, opened in 1862, was that of the Cowes to Newport, incorporated in 1859, while thirteen years later the Ryde and Newport opened a line from Newport to Ryde, and a line to Sandown was opened the same year by the Isle of Wight (Newport Junction) Railway. These three lines amalgamated in 1887 with the title of the Isle of Wight Central and this line undertook the working of the Freshwater,

Yarmouth, and Newport from the date of its opening in 1889 until 1913, when the latter commenced to provide its own rolling stock. The Isle of Wight Central operated a new branch to Ventnor in 1900, which it purchased in 1913 in order to compete with the Isle of Wight incorporated in 1860. This line had opened a route from Ryde to Shanklin in 1864, which terminated at Ventnor in 1866. Thus at the time of the grouping the island possessed three separate operating companies covering its 56 route miles, a distinct sign of insularity.

In North Devon closely allied to the London and South Western Railway was the 19-mile narrow-gauge Lynton and Barnstaple, also now absorbed in the Southern Railway.

Electrification is dealt with in another chapter, but it should be noted that no British railway prior to grouping had a more complete electrified suburban network than the London and South Western Railway.

Its development of Southampton Docks, which it purchased in 1892, has been phenomenal, and is probably the best example of what can be done by the combination of railway and port management. The first dock was built at Southampton in 1803, when the town had a population of less than 8,500, but the Dock Company was not incorporated until 1836. Blessed with a small difference in water level between high and low tides, it can berth the Atlantic liners ranging up to 56,000 gross tons with ease, in addition to a floating dock which can afford repair facilities to such vessels. By 1921 the population of Southampton itself was over 162,000, while serving an inland population within a hundred mile radius of over 13,000,000. The cargo handled is mainly of a highly valuable kind, such as perishables, and in 1926 totalled inwards 633,000 tons with almost the same outward tonnage. The net tonnage of the 3,211 ships inwards bound that year amounted to no less than 7,662,580 tons. With the present great development in hand it is safe to predict that Southampton will long remain a memorial to the enterprise of a great railway.

Table I, p. 49, is sufficient to give a general impression

of the growth of the London and South Western Railway over a period of sixty years.

The Somerset and Dorset Railway

By means of a line jointly leased with the late Midland Railway, now London, Midland, and Scottish, the London and South Western obtained a connection with the Midland Railway at Bath. The southern termini of this joint railway with a route mileage of over 100 miles are at Wimborne and Broadstone Junction near Poole. Rather less than 50 per cent. of the length of road is double-tracked, and it possesses as its nineteenth-century ancestors the Somerset Central and Dorset Central Railways. The former of these two lines received the Royal Assent to its Bill on July 1st, 1852, for the construction of a line from Highbridge on the Bristol and Exeter to Glastonbury, the Bristol and Exeter having exchanged for 400 shares of the new railway their canal between these two places. The share capital of this 12-mile line was £70,000. Opened in August, 1854, and constructed as a broad-gauge line, the railway was worked for about £4,000 per annum by its broad-gauge neighbour the Bristol and Exeter until the sixties.

Extensions eastwards to Cole authorized in 1856, northwards to Wells, and westwards to Burnham were completed during 1858 and succeeding years. It was at Cole that a junction was made with the Dorset Central. The first section of the Dorset Central from Wimborne to Blandford was authorized by an Act of August, 1856, but the final scheme, authorized the following year, was designed to connect the Somerset Central at Cole with the London and South Western line at Wimborne, and was to pass through Blandford. Like the London and South Western Railway it was built as a standard-gauge line, and late in the fifties powers were obtained to lay a third rail over the Somerset Central to permit through running from Wimborne. From 1861 the Bristol and Exeter ceased to operate broad-gauge trains over the Somerset Central, and the Somerset Central provided their own standard-gauge rolling stock including locomotive power

which worked as far south as Templecombe. When the railway had been opened throughout from Wimborne to Burnham in 1862 the Centrals of Dorset and Somerset combined to form the Somerset and Dorset Railway. But even in its amalgamated form the Somerset and Dorset found its length of haul too short for efficient operation, as is borne witness to by its financial difficulties in the late sixties. Moreover it lacked connections which would give it a northern outlet, both the Great Western and London and South Western in whose territories it lay forming connections in the main running east and west. This problem it solved by obtaining powers to construct a line to make a junction with the Midland Railway at Bath, this link being opened in 1874. In financial difficulties in 1875, as a consequence of the heavy cost of the recent extensions, the Somerset and Dorset made overtures to the Bristol and Exeter, but the latter's terms were not accepted. The importance to them of this standard-gauge link was already sufficiently realized by the London and South Western and Midland Railways, so, seizing their opportunity, they obtained a joint lease of the railway for 999 years. In order to avoid the reversing necessary at Wimborne for trains running between Bournemouth and Bath and the north, an avoiding line was constructed in the eighties, and there has since been gradually built up an important service of through north and south trains over the Somerset and Dorset Joint Railway.

Beyond the opening of a branch to Bridgwater in 1890 the most important development has been the increase in the coal traffic handled in the Radstock area of the Somerset coalfield. The importance of the line lies mainly in that it serves as an alternative north and south route, and places the present Southern in direct touch with the London, Midland, and Scottish, at points other than London. As a consequence, the amount of traffic transferred at Templecombe is of considerable proportions.

Table I, pp. 48–49, gives a general impression of the growth of the lines comprising the Southern Railway. The difficulty of obtaining any figures suitable for

TABLE I.—Growth of the Constituent

	South Eastern and Chatham.			
	S.E.R. 1865.	L.C.D.R. 1865.	1900.	1922
Total passengers carried (exclusive of season ticket holders)	16,141,838	9,241,966	73,834,089	51,578,141
Season ticket holders, all classes	5,340	2,061	31,823	54,270
Length of line open (route mileage)	297	132	609	632
Ratio of working expenses to gross receipts (operating ratio)	57%	59%	61%	78%
Minerals carried (tons)	208,361	[2]	4,422,848	5,099,512
General merchandise carried (tons)	741,998	307,845	2,232,976	1,957,475
Average fare per mile, in pence:				
(*a*) First class	1·96 [1]	2·44 [1]	[2]	[3]
(*b*) Parliamentary or third class	0·83 [1]	0·95	[2]	[3]
Paid up capital (£) (shares and debenture loans)	16,834,885	14,596,448	29,042,858 (S.E.) 27,589,925 (L.C.D.)	34,389,236 [8] (S.E.) 28,572,782 [8] (L.C.D.)
Average rate per cent. of dividend on ordinary capital	3·5	[2]	6 [5] & nil [6] (S.E.) Nil (L.C.D.)	6 [5] & 5 [6] (S.E.) ¾ (L.C.D.)
Compensation for personal injury (£)	70,726	2,632	5,865 [4]	12,927 & (passengers) 11,812 (workmen)
Rates and taxes (£)	51,032	12,959	275,981	369,449 & 265 (rates) (taxes)
Compensation for damage and loss of goods (£)	2,980	1,368	22,820	11,220
Total working expenses	715,136	265,273	2,912,000	6,822,938

* See previous pages for qualifying remarks. [1] Not express fares. Workmen's Compensation Act, 1897. [5] Preferred stock. [6] Deferred stock. [10] Includes workmen's weekly tickets. [11] Includes compensation for damage

statistical comparison will be realized, but the above make an attempt to show various aspects of railway efficiency and development. It is not claimed that the bases are in all respects comparable, but if exactly comparable figures only are used the table would be too limited to be of any interest.

COMPANIES OF THE SOUTHERN RAILWAY.*

LONDON, BRIGHTON AND SOUTH COAST.			LONDON AND SOUTH WESTERN.		
1865.	1900.	1922.	1865.	1900.	1922.
14,660,873	55,770,005	60,781,390	10,598,243	63,710,860	72,049,742
7,047	26,301	63,490	7,459	58,386[10]	58,857
275	448	448	576	898	872
52%	61%	79%	52%	62%	78%
511,194	2,909,815	3,410,445	481,282	4,032,355	5,239,878
559,894	1,353,159	1,292,477	958,463	2,379,245	2,641,837
1·92[1]	[2]	[3]	2·31[1]	[2]	[3]
0·90	[2]	[3]	0·98[1]	[2]	[3]
13,823,183	25,634,966	30,062,800 (created)	15,130,463	44,690,745	61,402,524
5·75	5⅛[9]	6[5] & 6½[6]	5	6⅛[7]	4[5] & 4[6]
4,504	5,784[4]	898 & 8,922 (passengers) (workmen)	25,000[11]	10,883[4]	1,710 & 11,608 (passengers) (workmen)
35,872	156,119	341,062 & 29 (rates) (taxes)	28,239	180,005	446,592 & 177 (rates) (taxes)
3,060	23,243	12,476	—	17,892	17,104
545,838	2,030,524	5,065,728	769,274	3,066,192	7,954,741

[1] Not available. [2] See next page. [3] Does not include compensation paid under [4] On major portion of shares. [5] Created. [6] On major portion of ordinary shares. and loss of goods.

The year 1865 was selected as being one of the earliest years for which full figures are available, but on the other hand the railway had by then approximated to the main outline of to-day. The years 1865 and 1900 are not strictly comparable with the year 1922, as the compilation of the accounts from 1913 onwards was changed to

conform to the provisions of the Railway Companies' (Accounts and Returns) Act of 1911. Further, in making any comparison of financial items regard must be had to the increases in charges and in rates of wages, prices of materials, etc., in post-war period.

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[3] Although figures giving the average fare per mile in pence for first and third class passengers for each individual railway are not available for the year 1922, the following figures for all the railways of the country (excluding the Great Northern Railway) are available for the year ended August 31st, 1921.

	Average Receipt per Passenger Mile. *d.*	Average Distance per Journey Miles.
First class . . .	2·76	25·09
Second class . . .	2·16	24·14
Third class . . .	1·26	10·44
All classes . . .	1·33	10·77

These figures exclude season-ticket holders.

CHAPTER IV

THE GREAT WESTERN RAILWAY. 1840–1927

As mentioned in a previous chapter, the Great Western Railway was completed between London and Bristol in 1841, being constructed to Brunel's 7-foot gauge, commonly known as the broad gauge.

It was not long before the result of this policy led to difficulties, for the early forties saw the construction of several lines which were later considered essential to the future prosperity of the railway from London to Bristol. Hence, although Brunel's gauge policy was partly due to his desire to keep other competitive lines out of the territory which he looked upon as properly belonging to Great Western influences, it became necessary to buy up such lines which his policy had not been successful in preventing from encroaching into his preserves. In some cases this led to a conversion of gauge from the narrow, or standard, to the broad gauge.

Since the incentive to join Bristol to London by rail had commenced in the former city, it is quite natural that the same year which saw the completion of this rail connection should see the projection south-westwards from Bristol also of the Bristol and Exeter Railway. This was opened in May, 1844, and up to 1849 was worked by the Great Western under a lease, at a rental of £71,957 per annum plus a toll of $\frac{1}{4}d.$[1] a mile per passenger and per ton of goods carried, and was amalgamated with the Great Western on August 1st, 1876. It also was a broad-gauge line, the first section of which, with a branch to Weston-super-Mare, was opened to Bridgwater in June, 1841 ; the following July saw the opening of the extension to Taunton, Whiteball Summit was negotiated

[1] *History of the Great Western Railway.* Sekon.

in 1843, and Exeter reached in 1844. The same year saw the opening of the Bristol and Gloucester, a broad-gauge line for which Brunel was engineer, and to which the Great Western had given financial aid. Its northern 9 miles into Gloucester were actually Great Western property, being part of the Cheltenham and Great Western Union line, for which an Act had been obtained in 1836. This line was not absorbed by the Great Western until July 1st, 1843. The Great Western had completed their broad-gauge line from London to Gloucester in 1845. It was the break of gauge at Gloucester, where the Bristol and Gloucester met the standard-gauge Birmingham and Gloucester, that led to the great battle of the gauges.

From Exeter a line, known as the South Devon, was constructed to Teignmouth along the shore, reaching Newton Abbot on December 30th, 1846. It had been originally opened as a locomotive line with Great Western engines on May 30th, and worked atmospherically from September 8th, 1847, to 1849. The line was run at a loss in 1848, so it was decided to revert to locomotives, an alteration which cost £259,000, and was a great blow to Brunel's reputation. The line had been opened to Totnes in July, 1847, and Plymouth, Laira, on May 5th, 1848. The Mill Bay extension was completed on April 2nd, 1849. This South Devon line, authorized by an Act of July 4th, 1844, was 52 miles long, its capital being £1,000,000, of which £150,000 was subscribed by the Great Western, £250,000 by the Bristol and Exeter, £50,000 by the Midland, namely the Birmingham and Gloucester,[1] and originally possessed no physical connection with the Bristol and Exeter. It is interesting as being the most important of the railways worked by atmospheric pressure.

Under this system, patented by Samuda Brothers, power was derived from atmospheric pressure contained in a large diameter tube placed between the rails. A vacuum was formed in the pipe immediately ahead of the train by pumping engines situated at intervals of about 3 miles along the line. An air-tight piston was fitted in the

[1] *History of the Great Western Railway.* Sekon.

pipe, while joined to the piston was a rod, which, passing through an opening in the pipe, was attached to the train. The great difficulty was to seal effectively the opening in the pipe after the passing of a train, otherwise the vacuum could not be complete and very considerable trouble was caused through the gnawing proclivities of rats. Nevertheless heavy gradients were overcome at a fair speed, though it should be remembered that trains were very light compared to those of to-day. The Kingstown and Dalkey and a portion of the Croydon Railway also became famous for railway traction by this method. On several of these lines remnants of the old pumping engine houses were visible quite recently, adapted for other purposes. The Torquay branch was opened throughout to Kingswear in August, 1864, though Torquay had been reached in 1859. The Kingswear, Port of Dartmouth and Torbay line was acquired by the South Devon in 1862.

Between Newton Abbot and Plymouth the line is very heavily graded, possibly due to the fact that Brunel, considering that this section would be worked atmospherically, did not deem it necessary to lengthen his line in order to avoid bad gradients, for with the atmospheric system steep gradients are no great drawback. The first bad bank is that known as Dainton, commencing 1½ miles west of Newton Abbot. For 2 miles the line rises at gradients varying between 1 in 98 and 1 in 36, the latter steeper than any part of the Gotthard; after Dainton tunnel the line drops at gradients of 1 in 37, 1 in 76, and so forth, but its steep section is shorter than on the eastward side. Down west-bound trains also have to negotiate the Rattery Bank, west of Totnes, the steepest part of which is 1 in 46, while the up east-bound trains have to ascend the 2-mile Hemerdon Bank, near Plympton, with a gradient as steep as 1 in 41. In autumn the difficulty of these banks is augmented by the fall of damp leaves on to the rails, which makes them slippery. It is partly due to the presence of these banks near the end of what has been for many years the world's longest express passenger run, that the "Riviera" is "Limited" in weight, although the advent of the "King" class of

engine has recently enabled two additional coaches to be hauled without assistance.

The western extension of the South Devon Railway was the Cornwall Railway, for which an Act was obtained, receiving Royal Assent in August, 1846. Of its capital of £900,000, the Great Western and its Associated Companies took £250,000. The line was opened from Plymouth, where it connected with the South Devon line, to Truro, in May, 1859, having been delayed by the industrial depression and financial difficulties of 1847 and the following year,[1] and to Falmouth by August, 1863. The Tamar was crossed at Saltash by Brunel's masterpiece, the Royal Albert Bridge, practically the only piece of single line to-day between Paddington and Penzance. Of broad gauge, the line was worked by South Devon engines, although the owning Company provided the carriages and wagons. Beyond Truro there existed the West Cornwall Railway dating from August 3rd, 1846, which had taken over the much older Hayle Railway, incorporated in June, 1834, and purchased for £80,000.

The West Cornwall was of standard gauge as became the descendant of a mineral line, and possessed a line from Truro to Penzance through Redruth with a branch to Hayle, opened throughout in 1852. With the opening of the Cornwall Railway to Truro in 1859, the West Cornwall, sanctioned in 1846, found it necessary to lay down a third broad-gauge rail for passenger traffic in 1860, after which date South Devon engines worked through to Penzance. It is curious that the West Cornwall should have become absorbed by the Great Western Railway in 1878, before the Cornwall Railway which connected them. The South Devon had itself been absorbed in 1878, while the Cornwall Railway was not absorbed until 1889.

The Great Western also possesses in Cornwall many branch lines, most of which were absorbed after being built by small local Companies ; the Liskeard and Looe line, worked from 1909 but only absorbed on January 1st, 1923, is typical of these. The Fowey and Newquay,

[1] *The History of the Great Western Railway.* Sekon.

opened in 1874 to standard gauge, was known as the Cornwall Minerals Railway ; it was worked by the Great Western Railway from October 1st, 1877, and bought by the latter in 1896, four years after the completion of the conversion of gauge from broad to standard throughout from Penzance to Paddington. Branches to Falmouth and Launceston, opened in 1865, Bodmin and Helston, 1887, and St. Ives in 1877, complete the story of Great Western influence in Cornwall, a county prominent in railway history through being the birthplace of Trevithick of steam carriage fame.

While the Great Western position in Cornwall has grown stronger year by year, one of the main visible signs of that influence has been steadily disappearing, namely, Brunel's famous wooden trestle viaducts, usually constructed with stone piers. As there is always the danger of fire with wooden viaducts, many of these have been replaced by deviations or embankments, and on others brick arches have been superimposed on granite piers, thus providing stronger structures to accommodate the heavier trains now run. Speed is naturally restricted by the undulating nature of the country ; the line abounds in curves, whilst often the gradients are steeper than 1 in 100. The need for Cornwall's early railways, such as the Redruth and Chacewater, arose from the prosperous nature of the tin and copper mining industry, but imported ores appear to have killed this once lucrative industry, although the high price and heavy demand has led to a welcome revival in the case of tin. The main source of mineral revenue is now derived from the haulage of china clay for shipment at Fowey, whence much is still taken by sailing and steam vessels to Runcorn for use in the Potteries, and in addition there is a very considerable foreign export trade of this commodity. The Great Western has developed the area very much by long-distance holiday passenger traffic.

As an example of the difficulties experienced in 1847 owing to the financial crisis which existed that year throughout the kingdom, even the construction of a comparatively short branch line from Newton Abbot,

sanctioned in 1846 and known as the Ashburton, Newton, and South Devon, had to be abandoned. It was 11 miles in length, and was estimated by Brunel to cost only £103,500. The project was not revived until 1864, the line being opened in 1872.

While by means of the Bristol and Exeter, the Great Western was extending westwards, it also planned extension northwards, and the earliest important branch to the north was that projected from Steventon through Abingdon to Oxford. As the citizens of both these places did not welcome the proposal, the line when opened on June 12th, 1844, commenced at Didcot, avoided Abingdon, and was careful not to vitiate the University atmosphere by the close proximity of smoking engines. Banished to Port Meadow, the stations at Oxford are worthy of the welcome they were accorded.

An Act for an Oxford and Rugby Railway through Banbury was passed in 1845, the line being opened to Banbury in September, 1850. No line was ever constructed between Fenny Compton and Rugby, as the Oxford and Rugby became part of the Oxford and Birmingham Junction Railway, with a capital of £1,000,000, the Act for which received Royal Assent in August, 1846. It was on this line that the first broad-gauge train ran from Paddington to Birmingham on October 1st, 1852, and exactly nine years later, on October 1st, 1861, the first narrow-gauge train ran from Birmingham to Paddington.[1] The London and Birmingham, which became part of the London and North Western Railway in 1846, regarded this as an excursion into their own preserves and attempted to buy up the line, which under the Act was to be leased to the Great Western Railway if 60 per cent. of the shareholders so desired. The fight between the Great Western Railway and the London and North Western Railway for this line was finally decided by Parliament in favour of the former. Brunel was the engineer for the line from Fenny Compton to Birmingham, the construction of which, like that of its neighbour the Oxford, Worcester, and Wolverhampton,

[1] *History of the Great Western Railway.* Sekon.

was let out to contractors. Constructed of mixed gauge, by Board of Trade order, the line was opened from Banbury through Leamington to Birmingham in 1852, a distance from London (Paddington) of 129¼ miles; while the Birmingham, Wolverhampton, and Dudley Railway, 14½ miles long, with a capital of £700,000, obtained its Act in 1846, and, serving as a feeding line, was also constructed on a mixed gauge, and was opened to Priestfield, where it joined the Oxford, Worcester, and Wolverhampton in 1854. On this latter line David Joy, of valve-gear fame, worked for some years in charge of the locomotive stock.

The fight between the London and Birmingham, that is, the London and North Western of more recent years, and the G.W.R. did not cease when the latter in its northwards progress, reached Wolverhampton, for since the early forties a project had been on foot to join Shrewsbury by railway to Wolverhampton and Birmingham. The Act for this line received Royal Assent in 1846, the intention being to join up with the South Staffordshire and London and North Western Railways at Birmingham, but by a late Act of 1848 an agreement was reached to build a joint station at Wolverhampton with the Oxford, Worcester, and Wolverhampton, and the Birmingham, Wolverhampton, and Dudley Railway. This alteration proved important, as it gave the G.W.R. a route to Shrewsbury. Though the line was built to take a broad gauge, if required, Brunel's 7-foot never seems to have been extended north of the Wolverhampton area. The Wellington to Shrewsbury section was a line jointly built with the Shropshire Union Railway and Canal Company—leased to the London and North Western Railway by an Act of 1847—and the Shrewsbury and Birmingham Company; the opening of this section in June, 1849, was followed by the opening of the Wellington to Wolverhampton section in the following November.

Shrewsbury Station was the joint property of the Shropshire Union, the Shrewsbury and Birmingham, Shrewsbury and Hereford (*vide infra*), and Shrewsbury and Chester Railways. The last named was the result of

an amalgamation which took place in 1846 of the North Wales Mineral Railway—authorized by an Act of 1844, and having a line constructed from Saltney near Chester to Ruabon—and the Shrewsbury, Oswestry, and Chester Junction Railway, which was authorized in 1845 and opened on October 16th, 1848, from Ruabon to Shrewsbury, with a branch to Oswestry from Gobowen. Its locomotives must have been amongst the earliest standard-gauge ones of the G.W.R. At Chester a joint station, opened in 1848, was built by this railway in conjunction with the London and North Western, the Chester and Holyhead, the Shrewsbury and Chester, and Birkenhead, Lancashire and Cheshire Junction Railways. From Chester northwards to Liverpool the most direct route was that of the Chester and Birkenhead Railway Company, whose line, originally single, was opened on September 22nd, 1840, but later doubled and so designed as to be adaptable for the 7-foot gauge if the G.W.R. should ever reach so far north as to absorb it. The Shrewsbury and Chester, and the Shrewsbury and Birmingham, always close partners, obtained running powers over this line in 1851. An agreement of this nature with the G.W.R. interests led to trouble with the London and North Western Railway which had hitherto worked closely with the Chester and Birkenhead, and also with the Birkenhead, Lancashire and Cheshire Junction Company, whose line from Chester to near Warrington was opened in 1850. As a result of internal pressure the directors of the Chester and Birkenhead cancelled their agreement with the Great Western interests. After considerable manœuvring for position on the part of the several companies at Chester, the Chester and Birkenhead was finally leased by the Great Western Railway and the London and North Western Railway by 1861, and the line is worked jointly to-day. The Shrewsbury and Hereford Railway, destined at a later date to become jointly owned by the G.W.R. and the London and North Western, was opened throughout in December, 1853. Leased nine years later, it was finally acquired by the parent companies in 1870.

An early railway which was later to form an important link line was the Monmouth and Hereford Railway, a broad-gauge line, 36¼ miles long, which was favoured at Paddington and whose Act received Royal Assent in 1845. The capital was £550,000, and powers were given to raise a loan of nearly £200,000 besides. The directors of an adjoining line, the Gloucester and Forest of Dean, the Act for which is dated 1846, owing to Great Western influences, had also been persuaded to adopt the broad gauge, Brunel acting as engineer. The second of these two lines made greater progress than the first, the construction of which was delayed owing to the difficulty of obtaining capital during the financial crisis of 1847, as was the case with many other lines proposed in the course of the mania of 1844.

In the meanwhile, a Hereford and Gloucester Railway, to run through Ross, had been proposed, which plan appeared more auspicious than that of the Monmouth and Hereford. As a result the Act for the Hereford, Ross, and Gloucester Railway was passed in 1851, Brunel estimating the cost to be £225,000, for the line of nearly 23 miles, and Brassey being among the contractors for this line. The Great Western Railway agreed to work the line from its opening, which took place throughout in June, 1855, although the first portion was opened in July, 1853, in return for 60 per cent. of the gross receipts, after deducting the interest charges on borrowed capital. The line was finally bought up by the Great Western Railway in 1862.

At Hereford the line from Ross and Gloucester came in touch with the Newport, Abergavenny, and Hereford, incorporated in 1846, which formed a link in the north to the west line through Hereford, Shrewsbury and Chester. The financial panic of 1847 seems to have delayed the construction of this line, in common with that of its neighbours. In spite of some vicissitudes, a double line of standard gauge was opened from Hereford to Pontypool in 1854, trains running over the Monmouthshire Railway, opened by 1853, from Panteg, south of Pontypool, to Newport, thus providing a through rail route from the

Bristol Channel to the Mersey, though goods had to be transhipped at Newport because the South Wales Railway was of the broad gauge.

The Act for the Monmouthshire Railway received Royal Assent in August, 1848, though the line was really the successor to several much earlier tram-roads and canals, which had been bought by the Railway Company from the Monmouthshire Canal Company. From the same source an interest in the Newport Dock was obtained and one of the early tasks of the railway was to convert the tram-roads into railways by altering the type of permanent way. In 1875 the Great Western Railway leased this line in perpetuity, but finally absorbed it five years later. In 1866 the Great Western Railway obtained powers to work the Wye Valley line which it absorbed by amalgamation in 1905. This line connected with the South Wales Railway at Chepstow, and at Monmouth with the Ross and Monmouth, a standard-gauge line for many years worked by the G.W.R., and absorbed in 1922.

The western part of the Newport, Abergavenny, and Hereford from Pontypool Road to Aberdare was delayed by the heavy engineering work required, mainly at the Crumlin Viaduct, which was finally completed in May, 1857. The construction of this striking viaduct, over 200 feet in height and 500 yards long, was a noteworthy engineering feat, and enabled the railway to make connections with coal and iron works in the Ebbw, Rhymney, and Sirhowy Valleys, as well as with Merthyr, Cardiff, and the Taff Vale Railway. The line was not opened to the junction with the Taff Vale at Quaker's Yard until January, 1858, but the previous year had seen the advent of G.W.R. interests through the latter's control of the Oxford, Worcester, and Wolverhampton, which together with the Worcester and Hereford (*vide infra*), and the Newport, Abergavenny, and Hereford, was to be worked as if one organization. Two years later, in 1860, the three lines were amalgamated together and became known as the West Midland. The Great Western leased the West Midland from July 1st, 1861, the two lines being consolidated in 1863. Closely connected with the West

Midland there was also the Severn Valley of 1853, with which the West Midland took the formation of an X, with its centre at Worcester. The Oxford, Worcester, and Wolverhampton, forming the two right-hand arms, stretching from just south of Wolverhampton to just north of Oxford, the Worcester and Hereford and the Newport, Abergavenny, and Hereford, formed the south-west arm, while the Severn Valley from Hartlebury, just north of Worcester, to near Shrewsbury formed the north-westerly arm of the X. This latter appears to have been worked from its opening as part of the Oxford, Worcester, and Wolverhampton.

Meanwhile, in August, 1853, Royal Assent had been given to the Act for a railway from Worcester to Hereford, to be built on the standard gauge, but so constructed as to be adaptable to conversion to broad gauge if an important northerly mineral traffic should develop from the broad-gauge South Wales Railway. At its western end the line was to make connection with the Shrewsbury and Hereford, and the Newport, Abergavenny, and Hereford Railways. The Shrewsbury and Hereford was a standard-gauge line whose Act had received the Royal Assent in August, 1846, and its authorized capital was £800,000. The standard gauge was adopted partly through London and North Western Railway influence, and partly to ensure a north to west route built throughout on one gauge. The line was opened as a single track southwards as far as Ludlow on April 20th, 1852, and throughout to Hereford on December 6th, 1853, at a total cost of about £9,500 per mile. It appears that land, parliamentary, and legal charges amounted to about 28 per cent. of the total cost. The line became jointly leased to the West Midland and London and North Western by an Act of July, 1862. It was acquired by these two Companies in 1870, and has remained so until this day, the L.M.S.R. now replacing its predecessor the London and North Western Railway. The Shrewsbury and Hereford came into its own with the opening of the Severn Tunnel in 1886, and provided a short route between Bristol, Crewe, and the north-west.

Heavy engineering work where the line crossed the Malvern Hills delayed the construction of the Worcester and Hereford, and caused the estimated cost to be greatly exceeded and the Midland and the London and North Western Railways definitely refused financial assistance. In 1856, with better financial conditions and indirect assistance from the Newport, Abergavenny, and Hereford, work started again ; the construction work was let out to Brassey, and the Oxford, Worcester, and Wolverhampton, and finally the Midland, expressed interest in the line. A double line was opened to Malvern in 1859 and single thence to Hereford in 1861. Lands were bought sufficient for doubling the western stretch, and during the last year or two the G.W.R. decided to double the Colwall tunnel, nearly 1,400 yards long. Another long tunnel exists at Ledbury. When the first part opened, the Oxford, Worcester, and Wolverhampton worked the passenger trains ; and the Newport, Abergavenny, and Hereford the freight trains ; the trains ran into the station owned by the first named at Worcester, and into the latter's station at Hereford.

In the early growth of the G.W.R., the point of greatest strategic importance would appear to have been Gloucester, an important city at the head of ocean shipping navigation of the Severn. It was the natural point of transhipment for the Midland inland towns, and at the same time was the most advantageous point at which lines from east to west could effect a comparatively easy crossing of the Severn.

It is not surprising then that in the early forties Gloucester was the scene of considerable railway promotion. An important line to be promoted in that area was the South Wales [1] from Chepstow to Pembroke, the Bill for which received Royal Assent in August, 1845. The South Wales Railway took over the Chepstow, Forest of Dean, and Gloucester Junction Railway, the Act for which had received the Royal Assent in December, 1845, and arranged to lease its own line to the G.W.R. as the

[1] *Accounts and Papers*, Volume XXXIX, Session February 4th to August 9th, 1845.

track was completed. It was hoped that much traffic would be handled by this line, upon completion of the Worcester and Hereford, the Shrewsbury and Hereford, and the Hereford and Gloucester Railways which at that time were projected.

Even at that early date the Fishguard route to Ireland seems to have been kept in mind, and the G.W.R. from the first nominated a third of the directors of the South Wales Railway, the authorized capital of which was £2,800,000. The proposed line was 211 miles, including branches. Though the line reached Swansea on June 18th, 1850, and was opened on each side of the tubular bridge at Chepstow, this latter was not opened for traffic as a single line tube until July 19th, 1852, the second being completed on April 18th, 1853. This formed the final link in railway communication between London and Carmarthen through Gloucester. The line was leased to and finally absorbed by the G.W.R. in 1863. In return for one-third of the net profits, the G.W.R. gave certain sums, varying with the mileage open, but reaching £46,000 on the completion of the line as broad gauge to Milford Haven in 1856.

The advent of the broad-gauge line into South Wales caused considerable trouble with mineral railways which already existed there and were descended from the earlier tram-roads upon which the steam engine had first been tried by Trevithick, nearly fifty years before. The South Wales Railway in January, 1854, made a junction with the standard-gauge Taff Vale, and the pious hope was expressed that those responsible for Taff Vale policy would undoubtedly see the manifold advantages of the broad gauge and convert their line accordingly. They failed completely to understand such a point of view, and on being threatened with a rival broad-gauge line, parried with a proposal to construct a standard-gauge line to compete with the broad-gauge Ely Valley line, leased to the G.W.R. from 1861 and amalgamated in 1903.

Another typical example of the gauge trouble occurred at Whitland, which the standard-gauge Pembroke and Tenby line, opened in 1863, had reached a few years later.

Passengers had to transfer and freight to be transhipped at Whitland. Hence efforts were made to connect the Tenby line with the standard-gauge London and North Western at Carmarthen, and this was done by the South Wales Railway laying down a third rail; a few years later, in 1872, the broad-gauge rail was removed from this main line altogether. The Pembroke line was finally taken over by the G.W.R. in 1897. It should be remembered that the broad-gauge started as a whim by Brunel was not wholly paid for at the time. It is incontrovertible that the capital cost of the G.W.R. would have been less but for the added expenditure, although to a certain extent this was offset by the possession of land for later widenings, which, owing to a greatly appreciated value, would have cost very much more at the later dates.

If Gloucester had been, and still was, a storm centre in the battle of the gauges, Worcester bid fair also to enter into the lists, and this important county town appears to have been wooed by both the broad-gauge G.W.R. and the standard-gauge London and Birmingham. On August 4th, 1845, an Act was passed permitting the construction of a broad-gauge line north from Oxford to Worcester and Wolverhampton, and it was the opposition to this Act that was the primary cause of the setting up of the Royal Commission, appointed that year, to inquire into the whole question. The London and Birmingham had planned to build a branch to Dudley, and hoped to obtain the Worcester traffic to London by building a branch from Coventry and Weedon to that city. Later, to provide a more direct line, this was changed to a branch from Tring through Aylesbury, with a branch to Oxford. The narrow-gauge Birmingham and Gloucester also entered into battle by proposing to deviate their line through Worcester. The proposed broad-gauge Oxford, Worcester, and Wolverhampton, finally, however, won the day, but largely owing to their proposal to provide a mixed gauge from Oxford; thereby providing a joint station at Worcester. The main object of this line, which is now known as the West Midland line of the G.W.R.

and passes through Stourbridge, Droitwich, Evesham, and Moreton-in-the-Marsh, of early railway interest, was to bring the mineral resources of Worcestershire and the fruit district of Evesham into direct rail communication with London, the South Coast ports—with a necessary break of gauge at Oxford—and the whole Great Western territory as it then existed. The Company was bound to lay down a third, or standard-gauge, rail if required to do so by the Board of Trade.

In 1846 branches were authorized to Birmingham, under the name of the Birmingham, Dudley, and Wolverhampton Railway, from Evesham to join the G.W.R. at Cheltenham, and also through Stratford to Birmingham. The G.W.R. subscribed half of the original £1,500,000 of authorized capital, guaranteed a $3\frac{1}{2}$ per cent. interest on the whole amount on completion of a double broad-gauge line throughout with mixed gauge north of Worcester. Brunel was the engineer, the actual construction work being let to contractors.

Although the Oxford, Worcester, and Wolverhampton Railway had originally intended to branch off from the Grand Junction near the latter's station at Wolverhampton, considerable delay occurred in the northern mileage of the line owing to the friction with the Great Western Railway over the gauge question, and the finding of additional capital to complete the line. As a result the Oxford, Worcester, and Wolverhampton turned to the Great Western's chief standard-gauge rivals, the London and North Western, and the Midland Railways, and an agreement for conversion to standard gauge was arrived at, but the law courts upheld the original agreement with the G.W.R. After a stormy period of considerable difficulty, the directors of the Oxford, Worcester, and Wolverhampton Railway received an offer to lease their line to the Great Western for nine hundred and ninety-nine years, on a basis of one-third of the gross receipts until these latter should exceed £200,000, after which the G.W.R. was to receive 50 per cent.; this offer was, however, rejected, owing to the broad-gauge clauses which it contained. This territory was surrounded by

standard-gauge lines such as that from Reading to Reigate, from Shrewsbury to Wolverhampton, and Birmingham to Gloucester and Dudley Port. Even the Oxford and Birmingham had a mixed gauge, thus a wholly broad-gauge line would have had to tranship traffic with all its neighbours.[1] By the fifties the standard-gauge was also advancing westwards through Bicester and Buckingham, and consequently, the Oxford, Worcester, and Wolverhampton's position had become rapidly precarious.

The line was finally opened in 1853, from Dudley to Wolvercot Junction, near Oxford, whereby the Oxford and Birmingham was joined, and, in conjunction with the standard-gauge line from Basingstoke to Oxford, a standard-gauge train could thus run through from Southampton to Birkenhead. As a consequence of the Report of the Gauges Commission, the Great Western Railway had laid a third rail, reputed to have cost £138,000, for 32 miles of the line from Oxford to Basingstoke, thus connecting the north with the south.[2] The policy of the Oxford, Worcester, and Wolverhampton was alternatively influenced by the broad-gauge Great Western Railway, and by the standard-gauge Midland and London and North Western Railways, until it was included in the West Midland (*vide infra*).

The Report of the Royal Commission's inquiry into gauges in 1846 recommended the use of the 4 ft. 8½ in. gauge for all future railway construction in Great Britain; the greater first cost of the broad-gauge not being offset, in the opinion of the Commission, by any equivalent reduction of maintenance or other recurring expenditure. The broad gauge at that time was considered to have certain advantages for passenger traffic in the realm of speed, but for freight traffic the 4 ft. 8½ in. gauge was eminently satisfactory and even considered more suitable to the needs of the country. As a result of the recommendation in favour of the standard gauge, a G.W.R.

[1] The Cheltenham to Gloucester section was the first to be laid with mixed gauge, the first broad-gauge trains running over it in October, 1847.

[2] *History of the Great Western Railway.* Sekon.

Bill to build a broad-gauge line in 1847 from Oxford to Birmingham resulted in a compromise, namely, the new broad-gauge line was to be laid with a third rail to form a standard-gauge as well. This expensive method of railway construction, known as the mixed gauge, was comparatively common on the G.W.R. in late years. The broad-gauge reached Penzance, Farringdon Street, Wolverhampton, and Victoria, S.E.R.

An early traffic of importance on the G.W.R. was that of coal from South Wales to the ships at Southampton through Basingstoke ; it is rather surprising to find that this traffic should have travelled by rail as early as the fifties. Much of the early revenue-earning traffic through the Severn Tunnel, when opened, was trains of coal from Aberdare for Southampton. A cursory glance at a map of South-western England will show how essential it was to obtain a shorter route by rail from Devon, Somerset, and even London to the South Wales towns than that through Gloucester. The Bristol and South Wales Union Railway, 15 miles long, for which an Act was passed in July, 1857, started the construction of a line from Bristol, with ferry piers on the banks of the Severn, at a point where the river is $2\frac{1}{4}$ miles wide, the rail and ferry service being opened in 1863. The G.W.R. took over this route in 1868. Junction was made with the South Wales Railway at Portskewett, and communication was kept open by this method until 1886, when trains first began to use the Severn Tunnel. The tunnel is a remarkable engineering feat, being 4 miles 636 yards in length ; Sir John Hawkshaw (1811–1891) was the consulting, and later the chief, engineer, though a pupil of Brunel's named Charles Richardson was the chief engineer at the commencement. Continual difficulties were met with in its construction, the water entering the tunnel in large quantities. At one time during its construction water entered at the rate of 27,000 gallons a minute. The saving in time to South Wales traffic was well worth the expense, the train and ferry service taking two hours for the journey from Bristol to Cardiff, which after the completion of the tunnel only required one hour. Great care

is taken with the operation of trains through the tunnel, loads and speeds being strictly limited.

Typical of the fact that the greater part of British railway mileage was built by locally raised capital and authorized as independent lines which later were absorbed by bigger neighbours, was the East Somerset Railway, running from the cathedral city of Wells to Witham, where it joined the Wilts, Somerset, and Weymouth railway. This line, with a capital of £1,500,000, and sponsored by the G.W.R. as early as 1845, was opened in 1858, while the Cheddar Valley line, an extension of the Bristol and Exeter, running westward from Wells, was opened in 1869. These three lines now form part of the G.W.R. system and were all originally of broad-gauge design. The last named, opened from Frome to Yeovil in 1856, is by far the most important, because it forms parts of the direct main line to the west, and of the London to Weymouth main line used by boat expresses to and from London, and by much perishable traffic from the Channel Islands. The East Somerset, together with the Wilts, Somerset, and Weymouth Railway, 129 miles in length, was converted to standard gauge on its absorption in 1874, though the final few miles of the line into Weymouth had always been of mixed gauge, owing to the fact that the standard-gauge Dorchester and Southampton, later a part of the London and South Western Railway, possessed running powers from Dorchester Junction into Weymouth. The following year saw the conversion of the Bristol and Exeter and its Cheddar Valley extension. Seemingly both lines were equally unkind to the third-class traveller in the fifties, for he was only permitted to travel to London from Weymouth by one train on each route, taking eleven hours by the G.W.R. and nine by the London and South Western Railway. The fastest trains took rather more than five hours. Though the Weymouth and Channel Islands Steam Packet Company worked a service from Weymouth from 1857, it was not until the end of the eighties that the G.W.R. built their own boats and took over the service.

The turning-point in G.W.R. history was the year 1859,

which witnessed Brunel's death on September 15th, at the comparatively early age of fifty-three. This same year saw the first real victory of the standard over the broad gauge, and this came from the G.W.R. itself when the broad-gauge trains were taken off between Oxford and Birmingham. In August of that year the Oxford, Worcester, and Wolverhampton Railway obtained the necessary permission to take up the broad-gauge third rail on its line. Thus the fruits of the great gauge battle of 1845 and 1846, which had been left drawn, but mainly in favour of the broad gauge, began to melt away less than fifteen years afterwards.

In 1861, with the leasing of the West Midland, the main part of which was the erstwhile Oxford, Worcester, and Wolverhampton, the G.W.R. agreed to run standard-gauge trains from Oxford to Paddington, through Reading. These changes in gauge were completed by the early seventies, as well as numerous branches as far apart as Aylesbury and Hereford, the most important route from Swindon to Milford Haven being converted by 1872. Some of the Devon and Somerset branches were converted in the eighties, while the main line to Penzance was converted in 1892. Just as the death of Brunel had been followed rapidly by the first sign of the fall from favour of the broad gauge by the Paddington authorities, so the death of Daniel Gooch, in 1889, Brunel's staunch assistant, who had been for many years responsible for the steam locomotive development on the line, was followed rapidly by the determination to scrap the whole broad-gauge system.

The system of transhipments had proved expensive, the mixed gauge was also expensive in first cost and maintenance, and where it existed through traffic to other lines invariably used the standard-gauge rails. The western counties of England owe much to the courage of the G.W.R. directors of 1890, who had the unpleasant and thankless task of changing a system which Parliament, through lack of detailed care, should never have permitted to commence. The cost of conversion of the rolling stock alone has been placed at £374,000 ; [1] here once again

[1] *History of the Great Western Railway.* Sekon.

is a case where British industry must bear the cost of the faulty decisions taken during the early nineteenth century.

The last broad-gauge train left Paddington on May 20th, 1892; thus was drawn to a close a rail network which at one time reached a mileage of nearly 1,500 and possessed well over 600 locomotives. These were nearly all withdrawn to Swindon, where are situated the rolling stock works of the G.W.R., a location chosen by Gooch in the forties. The conversion had been foreseen for years, and about 65 per cent. of the engines and about 70 per cent. of the carriages were convertible to standard-gauge, having bodies of 8 feet 6 inches wide.

The removal of the broad gauge seems to have imbued the authorities at Paddington with a redoubled enthusiasm which manifested itself mainly in the years which followed, in the construction of cut-offs, high speed passenger services, for which the line had been noteworthy from earliest broad-gauge days, and long distance non-stop trains. It has been seen how the G.W.R. reached Birkenhead in the north, Milford Haven and Penzance in the west, and Weymouth in the south, long before the nineties. Since the conversion of gauge the G.W.R. in the following twenty years consolidated the territory between these points, based on London as an apex.

The policy since the close of the nineteenth century has been mainly to construct cut-offs in order to reduce mileage as far as possible, and the success accruing from this policy has been remarkable. One of the most important of these cut-offs to be designed was that undertaken to a large extent in conjunction with the Great Central which would allow the latter an alternative route to London to that jointly owned with the Metropolitan through Rickmansworth. The G.W.R. intended to use this line as part of a short cut from London to Banbury. It diverges from the old route near Old Oak Common, and passing through High Wycombe and Bicester, rejoins the old line at Aynho, just south of Banbury. This cut-off was open by 1910 and permitted

the G.W.R. to offer a two-hour service to Birmingham, strongly competitive with the London and North Western, now L.M.S.R. In 1900 sections of the short cut to Plymouth and Taunton through Westbury were opened, whilst three years later occurred the opening of the Badminton cut-off. The latter materially assisted the services to South Wales, and paved the way for the opening of the Fishguard and Rosslare route to Ireland in 1906, which same year witnessed the completion of the Westbury short line to Taunton and the West. Prior to the war the Cunard New York express liners called at Fishguard. At that time their home port was Liverpool, but before the service was later transferred to Southampton. Further improvements were brought into use in the Swansea area in 1913. To improve their Birmingham and West of England connections, the G.W.R. opened their Stratford-on-Avon to Cheltenham line in June, 1907. Thus each boundary line of the G.W.R. triangle had been materially altered in a period of less than twenty years. The experiment of slipping mail coaches at speed was tried successfully about 1904.

The Taff Vale Railway was the most important of the individual South Wales lines, mainly subsisting on the transport of mineral traffic, which became part of the Great Western as a result of the grouping provisions of the Railways Act of 1921. Like the G.W.R. itself, the Taff Vale was designed by Brunel, though curiously enough as a standard-gauge line on account of its sharp curves, and possessed the honour of an incorporation as early as June 21st, 1836. The railway was to run from Merthyr Tydfil to Cardiff and was opened for passenger traffic by 1841. Even in its early days it achieved considerable prosperity, for its loaded traffic movement was assisted by favourable gradients, whilst a large proportion of the wagons returning over the adverse gradients were returning empties. The later part of the nineteenth century saw the maximum progress and prosperity of coal as a source of power, and it was natural that the railways, whose tonnage consisted mainly of coal, should benefit to an important degree from the growth of the world's

trade and commerce and the increased use of this commodity.

Cardiff, situated at the exit of the Bristol Channel, was excellently located for the shipment of bunker coal as well as coal for export to South America, Western France, the Mediterranean ports, and Eastern coaling stations. It is not surprising that the Taff Vale expanded rapidly, firstly by leasing the harbour of Penarth with its Dock and Railway in 1864, and a quarter of a century later by process of amalgamation. Thus August 26th, 1889, saw an important amalgamation of the original Taff Vale with the Llantrisant, Rhondda Valley, Treferig Valley, Dare Valley, and Cowbridge lines, as well as with the even more important Cardiff, Penarth, and Barry Junction, and the Cowbridge and Aberthaw. Although throughout its long history a standard-gauge line, at many points its lines impinged on those of the G.W.R., notably at Quaker's Yard in January, 1857, and also to a smaller extent on those of its South Wales rivals, the Rhymney and Barry Railways.

In 1921, out of a total originating tonnage of almost 8,500,000, coal, coke, and patent fuel accounted for over 7,750,000 tons. It is fair to assume that much of the remaining freight traffic and most of the passengers carried at third-class or workmen's fares were miners, their families, or those almost entirely dependent upon the prosperity of the coal trade, and the goods for their consumption.

Whilst the wholesale amalgamation policy adopted by the Railways Act carried with it, doubtless, many disadvantages, it is clear that no railway in the position of the Taff Vale could have weathered successfully the disastrous year of 1926 as a separate organization. Claims for lowered coal haulage and shipment costs are vociferous and numerous to-day, but it has only been through the subsidization of such lines by the traffic revenue received from other areas of the Great Western that the efficient maintenance of services in South Wales during the disastrous year of 1926 was made possible. The following figures covering the six South Wales ports of Cardiff,

Penarth, Barry, Newport, Swansea, and Port Talbot, give some idea of the trend of trade movement, with special reference to coal, during the last few years.

TABLE II.—Imports and Exports from South Wales Ports, 1913–27.

Year.	Imports.	Exports.	Total.
	Tons.	Tons.	Tons.
1913	5,142,620	42,006,031	47,148,651
1922	4,087,318	34,261,361	38,348,679
1923	5,839,930	38,496,025	44,335,955
1924	6,000,236	34,392,222	40,392,458
1925	5,302,207	29,778,373	35,080,580
1926*	6,037,726	13,774,762	19,812,488
1927	5,971,409	31,584,157	37,555,566

Port.	1925.	1926.	1927.
	Tons.	Tons.	Tons.
Cardiff	9,186,005	5,155,659	9,966,928
Swansea	7,030,985	4,838,306	7,765,945
Newport	6,080,086	3,631,551	6,500,093
Barry	7,608,600	3,752,167	8,384,370
Port Talbot	2,621,263	1,228,299	2,642,979
Penarth	2,553,641	1,206,406	2,295,251
Totals	35,080,580	19,812,488	37,555,566

	1925.	1926.	1927.
	Tons.	Tons.	Tons.
Coal and coke	26,403,466	11,297,668	27,880,816
Patent fuel	1,022,575	487,001	1,157,401

* Seven months' coal stoppage.

The Rhymney Railway was incorporated in 1854 and was authorized to construct 9 miles of line in the Rhymney Valley, which should join with the Newport, Abergavenny and Hereford Railway. The following year authorization

for an extension to the Taff Vale Railway was obtained with running powers over the latter to Cardiff. In 1858 a branch to the Bute Docks at Cardiff was completed, and in addition the main line from Rhymney was opened. Built mainly for coal shipment and famous for its operation of that type of traffic, it is somewhat surprising to find that owing to a trade depression and the delay in opening up the mines served by the line, much of its early revenue was derived from passenger and freight traffic. By 1860, however, the revenue from coal traffic equalled all other revenue, and during the sixties, with an extension of the railway to Caerphilly, and the authorization of a direct line of its own to Cardiff, the prospects of the Company looked rosier. This direct line was completed in 1871, as well as connections with the G.W.R. and the London and North Western. Four years later a 10½-mile extension owned jointly with the G.W.R. was opened, which brought in a valuable revenue, consisting of an import traffic of iron ore to the Dowlais Iron Works, over 1,000 feet above sea level. This traffic has to negotiate heavy gradients of 1 in 40, which, however, assist the flow of export coal traffic, which has been the main source of revenue of the several local South Wales lines.

As showing the progress made by the Rhymney Railway, 960,000 tons of coal and coke were carried down to the Bute Docks at Cardiff in 1880; by 1908 this had increased to 2,900,000 tons, while in the latter year 1¼ million tons was carried to Barry Docks as well. Revenue increased in these twenty-eight years from £154,000 to £337,500.

During the eighties a joint Rhymney and Great Western line was opened to Merthyr, since when some new mineral branches have been constructed. In spite of industrial troubles, due to lock-outs, strikes, and trade depressions, the line has been successful financially, though in 1875 it was hard hit by a prolonged strike. Ten per cent. dividends have been the rule for many years, though the present severe depression of the coal, iron and steel trades has hit the South Wales mineral traffic very hard, and there is little question that the forced amalgamation of

1921–1922 has saved the holders of original Rhymney stock from suffering great dividend reductions. Economically it is undoubtedly sound that the incidences of losses due to fluctuations in trade should be spread as widely as possible, on the same principle as insurance ; but it is hard to persuade the security holder of old G.W.R. stock that it is fair that he should be forced to shoulder the burden of a smaller line in times of depression when he has received no benefit from its prosperity in the past. However, a revival of trade should bring the balance out evenly over a long period of time, and the savings due to unified railway control in the South Wales mining area should increase the net revenue when the trade revival starts, by reducing overhead charges and competitive services to a greater degree than was possible before the amalgamation.

Another important South Wales coal-carrying line was the Barry Railway, incorporated in 1884 and therefore of more modern date than its neighbours. The first section of the Barry Docks and Railway, shortened in 1893 to the Barry Railway, was opened during December, 1888, being a branch from the Taff Vale Railway at Cogan to Barry Docks, though these latter were not opened until the following year at the same time as a line from the Rhondda Valley section of the Taff Vale Railway to Barry Docks, joining the earlier line at Cadoxton. An extension to Barry Island was opened in 1896, while the Vale of Glamorgan line, opened in 1897, stretching from Barry to Bridgend, has always been worked by the Barry Company.

Connecting lines with the Rhymney Railway and Brecon and Merthyr in 1901 and 1905 respectively were made ; the route mileage of the Barry Railway amounted to 47 miles just prior to its becoming a part of the G.W.R. in 1922. Built primarily for the carriage of coal, it possessed no passenger stations on a large part of its line until the late nineties, but later its passenger traffic developed steadily and at one time it ran pleasure steamers from Barry to the Somerset holiday resorts, an unusual type of business enterprise for a mineral carrying company. The service

of about sixty trains per day from Cardiff was successful in building Barry up as a residential suburb. The number of passengers carried in 1921 was over 2,750,000.

Barry is one of those examples of a town made almost completely by railway enterprise, since before the coming of the railway it possessed a population of 765 in 1891, as compared with a population of 38,945 in 1921. Mainly engaged on coal shipment, the gradients are in favour of the loaded coal trains coming down from the Rhondda and other Valleys. The success of Barry has been chiefly due to its position, jutting out as it does into the Bristol Channel, and with such an excellent supply of good quality coal a few miles inland it is hard to rival as a bunkering and coal port for export. Ships which have discharged at Avonmouth and Bristol can bunker at Barry on their outward voyages without going far out of their normal track, while tramp ships from Liverpool often find it advantageous to call on their way out to Panama, South America, the Cape, Australia, or the Far East. In 1889 when the first dock at Barry was opened, exports and imports amounted to somewhat over 1,100,000 tons; Barry to-day holds a record of 11,000,000 tons of coal shipped in one year. The method of coal shipment, like that of the neighbouring ports, is by means of hoists which raise the wagons and tip them, the coal passing through end doors. Coal is shipped at over 600 tons per hour by this method into one ship, the coal being weighed at the same time.

The Barry Railway, with its 88 miles of running line and nearly double this mileage of siding, possessed nearly two locomotives per running mile. It became part of the G.W.R. system in 1922 as a result of the passing of the Railways Act of the previous year.

Another South Wales line was the Brecon and Merthyr Tydfil Junction Railway, incorporated in 1859, the main line of which ran from Brecon southwards through Talyllyn and Dowlais Top to Bassaleg, where it joined the Monmouthshire, now G.W.R. The first section of this line was opened in 1863, and the last in 1867. The line also possesses branches to Rhymney opened in 1866, to

Merthyr opened in 1867, and Dowlais opened in 1863. This line is of considerable historical interest as its permanent way exists on what were some of the famous early South Wales tram-roads. The Rumney Tram-road, opened in the thirties and not to be mistaken with the Rhymney Railway, was taken over by the Brecon and Merthyr in 1863, while for a few miles near Brecon it was successor to the early nineteenth-century Hay Tram-road. The Sirhowy Tram-road also passed through Bassaleg, but the greater part of this line now forms part of the old London and North Western Railway. The gradients of the Brecon and Merthyr are extremely heavy and for many miles are steeper than 1 in 100 ; at one part of the line for over 6 miles there is a steady rise steeper than 1 in 40 ; in this section, however, the traffic is not heavy except between Brecon and Talyllyn Junction. Prior to absorption by the G.W.R. it possessed a route of 60 miles, and connected with no less than five other railway companies, all of which, except the London and North Western Railway, now form part of the G.W.R.

The Alexandra (Newport and South Wales) Docks and Railway was primarily a dock-owning rather than a railway-owning Company, but as the whole of its activities are now included in the G.W.R. some mention should be made of its growth. Under the name of the Alexandra (Newport) Dock Company, it was originally incorporated in 1865 to develop docks and any rails necessary in conjunction therewith and changed its title to that formerly mentioned in 1882. The Company's first dock of nearly 30 acres, known as the Alexandra North, was not opened until 1875, the railway acting as a connection between it and the Monmouthshire Railway, now known as the Western Valleys line of the G.W.R. Out of the total import and export trade of about 560,000 tons shipped that year, nearly 400,000 tons were coal.

By an Act of 1878, the Pontypridd, Caerphilly, and Newport Railway was designed to bring coal from the Aberdare and Rhondda Valleys to Newport. With the use of the Brecon and Merthyr line westwards from Bassaleg, the Rhymney Railway from Caerphilly Junction

to Penrhos Junction, the other connecting lines required were short lines from Penrhos to near Pontypridd on the Taff Vale Railway and from Bassaleg to the Alexandra (Newport and South Wales) Dock Company's line at Newport, the whole distance from Pontypridd to Newport being only 18 miles. This line was opened to Caerphilly in 1884 in the same year that the Alexandra Dock Company absorbed the Newport Dock Company. In 1886 the connecting line at the Newport end was opened, originally worked so far as mineral trains were concerned by the Taff Vale Railway. Passenger trains were worked later by Alexandra Dock Company's rolling stock, and the latter Company absorbed the Pontypridd, Caerphilly, and Newport in 1897. At a still later date G.W.R. passenger trains worked this line and the Alexandra Company worked the mineral trains in place of the Taff Vale Railway. In 1893 the Alexandra South Dock of about 20 acres was completed, and total imports and exports exceeded 4,000,000 tons, of which well over 3,500,000 was accounted for by coal shipments. In 1913 the coal shipments totalled about 6,000,000 tons, the system, like that of other South Wales ports, being by wagon hoist. This railway was noteworthy in possessing a siding mileage about ten times as great as its route mileage. Another important South Wales line, though mainly a dock owner, was the Cardiff Railway.

Since the G.W.R. took over these South Wales railways in 1922, over £2,000,000 has been spent in adapting and reconstructing their equipment so that 20-ton wagons can be employed in the coal shipment trade. To induce the use of these wagons a 5 per cent. rebate has been offered together with a reduction of $1\frac{1}{4}d.$ per ton in tipping and weighing charges. In 1925 total imports and exports at the Great Western ports amounted to over 35,000,000 tons.

Another small but important line included in the present Great Western system was the Midland and South Western Junction Railway stretching from Cheltenham to join the London and South Western Railway at Andover, passing through Cirencester and Swindon. It

possessed running powers into Southampton over the erstwhile Andover and Redbridge Railway, later absorbed by the London and South Western. The Andover and Redbridge, together with the Midland and South Western Junction, as the latter's title discloses formed a standard-gauge link between the Midland at Cheltenham and the South Western in the Southampton area. After a long-drawn-out fight during the " battle of the gauges " the Andover and Redbridge had been finally absorbed by the London and South Western Railway in 1863, but the fight concerning the Midland and South Western Junction Railway was destined to occur in the twentieth century between the Great Western, in whose territory it lay, and the L.M.S.R. which would have thereby tapped the valuable traffic of Southampton. The line was originally opened from Swindon to Marlborough in 1881, being opened throughout ten years later, though only by using until 1898 the Great Western's Marlborough branch. Of a route mileage of 63 miles, of which 34 were double-tracked, its capital expenditure had been about £2,000,000 up to the time of absorption by the G.W.R. on the passing of the Railways Act 1921.

In Central Wales, as a result of its absorption of the Cambrian Railway, the Great Western has included within its system an interesting series of lines serving the Welsh Coast towns of Cardigan Bay. These lines roughly took the form of a **Y**, with Pwllheli at the north-west extremity, Whitchurch at the north-east, where connection was made with the London and North Western Railway, whilst the southernmost point was Talyllyn Junction near Brecon. In addition there was a short branch to Aberystwyth from Dovey Junction and a narrow-gauge line, acquired in the twentieth century, running up the Vale of Rheidol. The earliest section opened was that from Llanidloes to Newtown in 1859, followed closely by the Oswestry and Newtown, and Newtown and Machynlleth in the early sixties. By 1864 Whitchurch had been reached through Ellesmere, and Talyllyn through Rhayader, while the Cardigan Bay lines were completed by 1869. The Cambrian worked the Wrexham and Ellesmere line,

opened in 1895, which brought it into touch with the English Great Central at the former town. Of a route mileage of 241 miles, in addition to 53 miles leased or worked, only 27 were double-tracked. With a capital expenditure of about £6,500,000 few British railways in modern years had a more difficult financial problem to face, since much of the country served remains sparsely populated, while the gradients are heavy over long stretches of line.

Other small lines included in the Great Western group, but too short to merit attention, were the Neath and Brecon, and Rhondda and Swansea Bay Railways, and the Cleobury Mortimer and Ditton Priors Light Railway.

TABLE III.—THE GROWTH OF THE GREAT WESTERN RAILWAY.*

	1865.	1900.	1922.
Total passengers carried (exclusive of season ticket holders)	17,603,798	80,944,483	128,639,316
Season ticket holders, all classes	2,973	49,118	91,326
Length of line open (route mileage)	1,256	2,627	3,559
Ratio of working expenses to gross receipts (operating ratio)	49%	62%	81%
Minerals carried (tons)	4,832,415	30,076,786	61,817,643
General merchandise carried (tons)	2,360,852	7,423,724	11,825,309
Average fare per mile (pence):			
(*a*) First class	2·03 [2]	—[3]	—[4]
(*b*) Parliamentary or third class	0·94	—[3]	—[4]
Paid up capital (£) (shares and debentures)	42,165,121	85,946,413[5]	142,277,714 [6]
Average rate per cent. of dividend on ordinary capital	2·0 [6]	4⅝	8
Compensation for personal injury (£)	40,061	18,015	22,038 & 58,439 (passengers) (workmen)
Rates and taxes	58,754	412,969	1,535,89⅜ & 156 (rates) (taxes)
Compensation for damage and loss of goods (£)	23,627	62,976	132,756
Total working expenses	1,772,144	6,902,579	27,527,356

* See page 48 for qualifying remarks. [2] Not express fares.
[3] Not available. [4] See page 50. [5] Created.
[6] On major portion of shares.

Table III, p. 80, is sufficient to give a general impression of the growth of the Great Western Railway over a period of sixty years.

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CHAPTER V

THE LONDON, MIDLAND, AND SCOTTISH RAILWAY. 1840–1927

The London and North Western Railway

In an earlier chapter [1] was traced the history of the Liverpool and Manchester and London and Birmingham Railways, which may be looked upon as the forbears of the famous London and North Western Railway, which in 1923 became so important a constituent of the London, Midland, and Scottish.

By 1840 the Grand Junction Railway, incorporated in 1833, had been completed, and this formed a link between the two above-mentioned lines, since it ran from Warrington, on the Liverpool and Manchester, to Birmingham, where it connected with the London and Birmingham. In 1840 the Grand Junction absorbed the Chester and Crewe, and in 1845 the Liverpool and Manchester, the Leigh and Kenyon, Bolton and Leigh, and Kenyon and Leigh Junction Railways. Meanwhile the London and Birmingham had absorbed the Warwick and Leamington in 1843. It was not, however, until the following year, 1846, that the Manchester and Birmingham,[2] London and Birmingham, and Grand Junction Railways, by an Act [3] which received the Royal Assent on July 16th, combined to form the London and North Western Railway, with a capital of almost £17,250,000 and loans of almost £5,750,000.

By means of the North Union Line, incorporated in

[1] Chapter II.

[2] Under the amalgamation agreement the paid-up capital of this Company on February 1st, 1846, was reckoned as £1,440,000.

[3] 9 and 10 Vic. cap. 204.

1834,[1] which ran from Newton, near Warrington, to Preston, and which became in 1846 jointly owned by the Grand Junction and Manchester and Leeds, afterwards Lancashire and Yorkshire, the London and North Western reached as far north as Preston. Northwards from Preston ran the Lancaster and Preston Junction, incorporated in 1837, and opened on June 26th, 1840. Further north the Lancaster and Carlisle, dating back to 1844, was opened to Carlisle on December 17th, 1846, with a branch to Windermere the year following. The London and North Western Railway was able to run through trains to within a few miles of the Scottish Border by arrangement with these two railways, the former of which was amalgamated with it in 1859, and the latter in 1879. Agreement had been reached with the Caledonian regarding through running to Scotland as early as 1847, the year of the opening of Carlisle Joint Station. The London terminus of this West Coast route to Scotland, as it afterwards became known, was at Euston Grove, at that time on the outskirts of London. Like several of its later neighbours, its departing trains had to ascend a steep gradient of 1 in 66 and 1 in 75. Since locomotives were not regarded as suitable for such work in the thirties, trains were hauled by rope operated by a stationary engine, from Euston to Camden. The same system was adopted at Liverpool, and even in the twentieth century was used by the North British Railway at its Glasgow terminus.[2]

Euston terminus was and still is of a very imposing type in contradistinction to nearly all other station buildings in Great Britain. Its Doric arch, completed in 1839, still gives one the impression that the designers, even at that date, saw that its destiny was to be a great gateway to the north. Perhaps they also foresaw that for many thousands it would be a gateway to the New World, for the Allan Line opened their service to Canada

[1] This railway had taken over in 1834 the Wigan branch and the Preston and Wigan railways, both incorporated in 1830.

[2] Rope system on Cowlairs Incline discontinued from November 1st, 1908.

early in the nineteenth century, the Cunard Line their service to the United States in 1840, followed in later years by the White Star and other lines which made Liverpool their headquarters. Liverpool, though rivalled by Southampton in some respects to-day, has been to many emigrants what they regard as possibly a last view of England. Erected in 1837, the Doric arch at Euston cost £35,000 ; it is of Yorkshire stone and rises to a height of over 70 feet. From the first there were four lines between Euston and Camden over which section whistles were used as signals to the engine house at the latter place.

The Birmingham terminus was at Curzon Street, now converted into a freight station, while the Grand Junction terminus was near by. The present New Street Station, which was jointly owned by the London and North Western and Midland Railways, both now L.M.S., was opened in 1852.

Meanwhile South Lancashire and Cheshire had been the scene of continuous railway development. The Manchester and Birmingham Railway scheme, which, by the way, never arrived nearer to Birmingham than Crewe, had received its Act of Incorporation from Parliament in June, 1837. Its total capital, including loans, amounted to £2,800,000, and its plan was really the amalgamation of two rival schemes—one to join Manchester, at that time rapidly developing as a manufacturing and railway centre, to the Birmingham and Derby at Tamworth, the other to join Manchester to the Grand Junction at Stafford. The Manchester and Birmingham plans in reality consisted of two lines, both terminating at the London Road Station in Manchester, which was to be used by the proposed Manchester and Sheffield, the earliest constituent of the Great Central Railway, in return for a rental charge.

The westerly branch of the Manchester and Birmingham was the line from London Road to Crewe through Wilmslow and Chelford. Opened throughout on August 10th, 1842, this line, though only 30½ miles long, was afterwards destined to be a most important link in the London and

North Western Railway system by which it was taken over in 1846. What was to be the main line through Congleton from Manchester to the Potteries and the south never materialized as part of the Manchester and Birmingham, but was repromoted as the Churnet Valley scheme, which effected connection with the Midland Counties at Derby, and the Birmingham and Derby at Burton-on-Trent; but this is rather North Staffordshire Railway than London and North Western Railway history. A branch, however, of the Manchester and Birmingham was opened to Macclesfield in 1845.

At Crewe, besides transferring traffic to the Grand Junction Railway, the Manchester and Birmingham was in touch with the Chester and Crewe, a line which had also received the Royal Assent to its Bill in 1837. The capital per mile of the latter was much smaller than that of the Manchester and Birmingham, due doubtless to the easier country passed through, though its line had to be carried over the Weaver and Ellesmere Canal. Opened on October 1st, 1840, this Chester and Crewe line was taken over the next year by the Grand Junction, and connection made at the cathedral city with the Chester and Birkenhead line,[1] which was incorporated in 1837 and amalgamated in 1847 with the Birkenhead, Lancashire, and Cheshire Junction.

In 1844, two years before the actual formation of the London and North Western, an Act had been passed for the Chester and Holyhead Railway, which was to extend the Crewe and Chester and bring Ireland several hours nearer to London. The engineer for this line, destined to be the route of the famous Irish Mail, was Robert Stephenson, though the survey had been made by his father, George Stephenson. To the younger Stephenson there exists to-day one of the finest of memorials, namely the Britannia Tubular Bridge over the Menai Straits between the mainland of Wales and the Isle of Anglesea, which cost over £500,000. On a larger scale than the Conway tubular bridge on the same railway, which cost £110,000, it consists of two independent tubes, each

[1] See Chapter IV. *History of the Great Western Railway.*

nearly 1,500 feet in length, the centre tower being built to a height of 221 feet in order to permit ships a clear passage, a stipulation made by the Admiralty. It took over four years to construct, the tubes being floated into position, and constructed of cast-iron boiler plates. Robert Stephenson's original concept was for two cast-iron arches, which, however, did not meet with favour at the Admiralty.[1]

This Chester and Holyhead line, incorporated in 1844, was opened throughout in 1850, and to its construction had been ascribed by some the amalgamation of the London and Birmingham, and Grand Junction in 1846, since the latter held the connecting line between Chester and Crewe. In fact, this was probably an added incentive, but the amalgamation was primarily due to the natural desire of both companies to increase their average length of haul, reduce overhead expenditure, and obtain at the same time a through connection between the rapidly growing industrial area in South Lancashire and the seat of the Government in London, which throughout English history has been the centre of trade and finance, as well as the main port of the kingdom. The Chester and Holyhead became part of the London and North Western Railway in 1858.

It will be noticed that even in the thirties much in railway politics hinged on Crewe, which in pre-railway days was practically non-existent. Since the Crewe and Chester, Manchester and Birmingham, and Grand Junction lines all met there, it is not a matter of surprise that the Grand Junction removed their locomotive works from Edgehill, Liverpool, to Crewe in 1843, and employment was provided for 160 men. Close to coal and iron supplies, Crewe as a locomotive centre was ideal, and it was due to Francis Trevithick, son of Richard Trevithick, sometimes known as "the father of the locomotive engine," that this position was chosen for what are to-day probably the most famous railway locomotive works in

[1] *High-ways and Dry-ways*, by Sir F. B. Head. 1849. *General Description of the Britannia and Conway Tubular Bridges*, by A Resident Assistant. 1849.

the world. At a later date Trevithick became, as locomotive superintendent for the Northern Division, responsible for all locomotives running north of Crewe on the London and North Western Railway. Some of the products of Crewe are dealt with in a later chapter [1] dealing in outline with the development of the steam locomotive ; but of especial note is Francis Trevithick's locomotive "Cornwall," built in 1847, with 8-foot driving wheels. This locomotive is still running, though in very different form to that in which she originally appeared.

From a mileage of rather over 400 miles at the time of its formation in 1846, the London and North Western Railway extended its influence rapidly in the fifties and sixties. Almost the first big absorptions after its formation were the Huddersfield and Manchester of 1845, and the Leeds, Dewsbury, and Manchester of the same year, both lines being taken over in 1847. Next year brought the opening of the Chester and Shrewsbury, and Manchester South Junction and Altrincham Railways.

Although the Bedford and Dunstable branches had been taken over by the London and Birmingham in 1845, and the Rugby and Leamington line and the Aylesbury branch in 1846, other branches south of Crewe were added in later years ; thus, Oxford and Buckingham were reached in 1847, and Cambridge in 1865. Northampton, which had successfully opposed the presence of the London and Birmingham, had seen the error of its ways by 1844. As a consequence a line was opened from Blisworth through Northampton to Peterborough in June, 1845, and at a later date the present alternative main line from Roade to Rugby via Northampton was constructed. North of Rugby the most important early addition to the London and North Western was the Trent Valley line, incorporated in 1845, running from Rugby through Nuneaton and Tamworth to Stafford, thus bringing the London and Birmingham much closer to Crewe and the Manchester and Birmingham Railway. With the formation of the London and North Western the unfinished

[1] *Vide* Chapter VIII.

Trent Valley was taken over and later opened on December 1st, 1847. This served to reduce the mileage and travelling time between London and the north by avoiding Birmingham. As showing the importance of this link it is now four-tracked almost throughout and few London to the north trains travel through Birmingham and Wolverhampton to Stafford.

Following the acquisition of the Chester and Holyhead in 1858, the London and North Western Railway greatly extended its sphere of influence in Wales during the sixties and seventies. In North Wales, the Bangor and Carnarvon, incorporated in 1851, the Vale of Clwyd of 1856, and the Conway and Llanrwst of 1860, were taken over in 1867; in South Wales, the Merthyr, Tredegar, and Abergavenny Railway of 1859 had been taken over the year before. In 1868 the Central Wales, opened five years previously, and its extensions were absorbed; while in 1869 the Brynmawr and Blaenavon, and two years later the Carnarvon and Llanberis and Carnarvonshire Railways, part of the latter being the old Nantile Railway of 1825, were taken over. During the following years the Anglesea Central, Denbigh, Ruthin, and Corwen, in addition to the famous Sirhowy Tram-road of 1802, as well as a section of the Brecon and Merthyr became part of the London and North Western Railway.

Its increasing power in Lancashire is borne witness to by its absorption in 1864 of the St. Helens, which in its turn had taken over the St. Helens and Runcorn Gap line, dating back to 1830. The early Cromford and High Peak, incorporated in 1825, became London and North Western property in 1862, as did the Stockport, Disbury, and Whalley Bridge in 1866. The next year the London and North Western acquired the Warrington and Stockport, which had been incorporated in 1853.

This rapid growth naturally brought it into territory already served by other important railways, this very fact doubtless being largely due to its desire to take over small neighbouring lines prior to their being absorbed by competitive railways. Thus, on the west one finds that the London and North Western Railway was unable to

obtain complete control and several lines on the Welsh border became jointly leased to and owned by the Great Western and London and North Western Railways ; an example of such is the Birkenhead, successor to the Birkenhead, Lancashire, and Cheshire Junction of 1846. This Birkenhead Railway became leased to the Great Western and London and North Western Railways in 1861. Further south the Shrewsbury and Hereford Railway, authorized in 1846 and opened throughout in 1853, became jointly leased to the G.W.R. and London and North Western Railway in 1862, while the adjoining Shrewsbury and Welshpool followed suit in 1865. The former was actually bought up by these two companies in 1871. By means of the Shrewsbury and Hereford and running powers over the G.W.R. from Hereford to Abergavenny, the London and North Western was able to tap a valuable traffic in South Wales.

The other local railway in the Salop district, the Shropshire Union Railways and Canal Company, which with the G.W.R. owned the Shrewsbury and Wellington, had passed wholly under London and North Western influence as early as 1847. The Tenbury line of 1859 was jointly leased to the G.W.R. and London and North Western in 1866, as was also the Wrexham and Minera Railway. As will be seen from reference to a present-day railway map these lines still remain jointly owned by the G.W.R. and the L.M.S.R., successor to the London and North Western, though within the last few years rearrangements with regard to working have generally speaking handed over the joint lines south of Shrewsbury to the G.W.R. to operate, and those north of that town to the L.M.S.R.

Mention should also be made of the Birmingham, Bristol, and Thames Junction of 1836, which was known as the West London in 1840, and became London and Birmingham in 1845. The Great Western at a later date became jointly interested in this line between Old Oak Common and Addison Road, Kensington, as well as the southerly extension to Clapham Junction, in which the London, Brighton, and South Coast, and London and South Western Railways were also jointly interested. In

this way both the London and North Western, and consequently the L.M.S.R. and the G.W.R., were connected by this important link and its extension with the railways south of the Thames. By 1859 traffic had become so heavy in the London area that a third line was added from Bletchley to Camden.

While the London and North Western and G.W.R. were thus being forced into joint ownership in the west, the same situation was rapidly developing in Lancashire in connection with the Lancashire and Yorkshire. Almost the first line jointly taken over by these railways was the Preston and Wyre Railway and Dock in 1849. This rivalry centred mainly in connection with the Lancashire Union line of 1864 which owned some important mileage jointly with the Lancashire and Yorkshire, but it was not until 1883 that this became jointly owned by the London and North Western and Lancashire and Yorkshire. These two lines, as successors to the Grand Junction and Manchester and Leeds respectively, had owned jointly since 1846 the old North Union of 1834, and had taken over in 1867 the Fleetwood, Preston, and West Riding, of 1856, whose ancestor was the Preston and Longridge of 1836. The year 1867 saw some important extensions to the Southern Division of the London and North Western Railway by the acquisition of the South Leicestershire Railway of 1860 and the much earlier South Staffordshire of 1846. Finally, the London and North Western strengthened its hold on the valuable Black Country by absorbing, in the same year, the Birmingham, Wolverhampton, and Stour Valley, incorporated in 1846, and opened in 1852.

These acquisitions brought the London and North Western into close contact with the Midland at Nuneaton, and the Ashby and Nuneaton line became jointly owned by these two railways the same year. The North and South West Junction line in the London area, authorized in 1851 and opened for passenger traffic in 1854, gave the London and North Western another important connection with the London and South Western Railway. The sixties also saw the London and North Western strength-

ening its position in the Cannock Chase coal area by the absorption of small lines serving the collieries.

The Northern Division extensions were mainly in the Lake District and connected with mineral development. The previously mentioned Lancaster and Carlisle Railway, incorporated in 1844, had absorbed the Kendal and Windermere in 1845 and the Lancaster and Preston Junction, dating back to 1837, in 1859. The Whitehaven Junction Railway, incorporated in 1844, and the Cockermouth and Workington of 1845, became London and North Western Railway property in 1866 and the adjoining Whitehaven, Cleator, and Egremont in 1877, although a year afterwards one finds the Furness Railway, whose history is shortly outlined later in this chapter, financially interested in the same railway. The Cleator and Furness of 1866 became jointly owned by the London and North Western and Furness Railways in 1878.

With such an enterprising line as the London and North Western Railway it is not a matter of surprise that the Scottish Border proved no adequate bar to its progress, and not contented with harmonious working arrangements with its northern partner of the West Coast route, the Caledonian Railway, also dealt with later in this chapter, it became interested jointly with the Caledonian, Midland, and Glasgow and South Western Railways in the Portpatrick Railway, incorporated in 1857, thereby obtaining an interest in the Stranraer and Larne service to Ireland.

What is, however, a matter of astonishment is that it should have crossed the Irish Sea and obtained an interest in an Irish railway, namely the Dublin and Drogheda of 1869, which now forms part of the Great Northern Railway of Ireland.[1]

It is clear that by 1870 the London and North Western system stood practically the same as it did prior to the formation of the L.M.S.R. in 1923. The only new con-

[1] The Dublin and Drogheda was amalgamated with the Northern of Ireland in 1875 and the Northern Company was amalgamated with the Ulster Company to form the Great Northern of Ireland the following year.

struction of considerable importance during the seventies was its joint line with the Great Northern in Leicestershire and Nottinghamshire, authorized in 1874. Opened in 1879 through Melton Mowbray, its importance was out of proportion to its length, which was only 45 miles, because it gave the London and North Western Railway entry into Nottingham and its surrounding coal-fields, and by running powers to Doncaster it could tap the South Yorkshire coal-field also.

But if its construction of new mileage now ceased to be important, its development of traffic, with the consequent widenings this necessitated, more than took its place, and the table reproduced at the end of this section shows how this all-important British line developed during years which were destined to see enormous prosperity in Great Britain. In the growth of that prosperity the London and North Western Railway played no small part.

Unique amongst British railways, or for that matter amongst railways abroad also, with the exception of the Pennsylvania Railroad in the United States, was its policy of rolling its own rails [1] at the Crewe Works, to which reference has been made earlier in this chapter. And, perhaps, to this fact may also be attributed the policy of using 60-foot rails. Crewe works employ about 8,000 men out of a population of about 50,000. A town built up entirely by the railway, the population of Coppenhall, as it was then known, in 1831 was only about 150. Unlike most of the other railways its carriage works were located in a different place, namely, Wolverton on the old London and Birmingham, although for a few years carriages had been constructed at Saltley. Wagon construction has been carried out at Earlestown, near Warrington, since 1853.

The London and North Western Railway was famous for its cross-Channel steamship services from Holyhead to Kingstown, Dublin (North Wall), and Greenore; the Kingstown service dates back to 1848 when it was run by the Chester and Holyhead Railway. These services

[1] The first steel rails were rolled at Crewe in 1861.

were primarily the cause of the construction of the Chester and Holyhead and have proved an excellent feeding service for its main line, although in recent years traffic has declined as a result of the unsettled times in Ireland. In addition a joint Irish Service was run with the Lancashire and Yorkshire Railway to Belfast from Fleetwood. Important construction work in the twentieth century was the building of the Wilmslow and Levenshulme line in the territory of the old Manchester and Birmingham Railway. This work was completed in 1909, and permitted London and Manchester trains to avoid Stockport.

A London local line which was finally absorbed together with the London and North Western in the L.M.S.R. group was the North London, which for many years to all outward appearances had been part of the London and North Western. The North London was brought into being by an Act of August, 1846, as the East and West India Docks and Birmingham Junction Railway; the line was constructed from Chalk Farm, between Willesden Junction and Euston, to Poplar and Bow, connecting at its eastern end with the Eastern Counties and London and Blackwall, both later part of the Great Eastern, and by means of this connection used the London and Blackwall's terminus at Fenchurch Street until some time after the completion of its own Broad Street Station in 1865. Like its neighbour the London, Tilbury, and Southend, it scorned the third-class passenger, and no third-class carriages were run until 1875, though the second-class fares were very cheap. Forming a useful freight traffic link between such lines as the Great Eastern and Great Western, it also dealt with an important suburban passenger service from Broad Street mainly to Hampstead, Richmond on the North and South West Junction Railway, and to the Great Northern line stations beyond Finsbury Park, to which it had running powers. To deal with this growing passenger service a large percentage of the total mileage had been electrified, notably to Kew and Richmond, while in 1908 a close agreement was entered into whereby the London

and North Western would supply the chief superintending officers and also be responsible for the supply of rolling stock for twenty-one years. The total route mileage of the line was only 16 miles, but it carried in 1922, not including passengers by London and North Western electric trains working over the North London, nearly 11½ million originating passengers, including 4½ million workmen, and had an issued capital of almost £4,000,000. One of the results of this close agreement was the inauguration of a City to City express complete with typewriting room from Birmingham to Broad Street, London, in two and a quarter hours by London and North Western route.

Table IV, p. 116, is sufficient to give a general impression of the growth of the London and North Western Railway over a period of sixty years.

The Midland Railway

The earliest component part of the famous Midland Railway was the Leicester and Swannington of 1832, to which previous reference [1] has been made.

From almost the first, however, Derby has been connected with the fortunes of this railway, for the Midland Counties Railway, incorporated in 1836 and opened on May 30th, 1839, joined Derby to Nottingham and Rugby, and made the first named county town its headquarters. The route mileage was approximately 57 miles. Another important early constituent of the Midland was the North Midland. Conceived by George Stephenson, this line was planned to run from Derby to Normanton, where connection was to be made with the Manchester and Leeds Railway and York and North Midland Railway. The North Midland, incorporated in 1836, is said to have cost nearly £3,000,000, although only 73 route miles in length. Partially opened on May 11th, 1840, it gave connection at Masboro' with the Sheffield and Rotherham, another Stephenson planned line which was incorporated in 1836, opened on October 31st, 1838, and amalgamated with the Midland Railway late in 1844. The 48½-mile

[1] *Vide* Chapter II.

Birmingham and Derby Junction, incorporated in 1836 and opened on June 30th, 1839, gave the latter town an outlet to the west, and converted it into a most important railway junction, as well as offering a through connection between the London and Birmingham and the Yorkshire towns.

The combination of the Midland Counties, the North Midland, of which Robert Stephenson was at one time general manager, and the Birmingham and Derby Junction into the Midland Railway took place in 1844 by an Act passed on May 10th. This Act is important, for it gave a great stimulus to amalgamations, many of which took place in the following ten years—such as the formation of the London and North Western in 1846—and it started a problem which has faced successive Parliaments until to-day. It had been of comparatively small moment to decide as to whether a line like the Liverpool and Manchester should be allowed to combine with the Bolton and Leigh, 9 miles in length ; but when it came to combining railways with track mileages of nearly 200 miles, some national policy had to be determined. However, the advantages apparent or claimed by the Midland, as resulting from amalgamation, were substantial enough to ensure that the policy should be permitted to other lines, and it is not until the late fifties that serious opposition is found to develop against the amalgamation principle.

The Midland did not lose much time in consolidating its position and pushing on with new construction work, for the Erewash Valley line, terminating at Clay Cross, and serving a famous colliery district, was opened in 1847 just two years after the well-known Leicester and Swannington had become part of the Midland system. It also reached Burton-on-Trent, whilst the intervening year, 1846, had witnessed the absorption of another local enterprise, namely, the Ashby-de-la-Zouch Canal and Tramways.

George Hudson, the Yorkist "King of Railways," was the main force behind this policy of extension, and further evidences of his activity, backed by an efficient manage-

ment at Derby, had been the arrival of the Midland at Gloucester, and later at Bristol and Nottingham. Gloucester was reached by way of Birmingham, from which point a railway, the Act for which had been passed in 1836, was opened to Gloucester in 1840. Welcomed by the London and Birmingham, since it was to be built to standard gauge, the former permitted it to make use of its Birmingham terminus at Curzon Street and, hence, into the more recent joint Midland and London and North Western station at New Street. Thus the standard gauge extended as far into the south-west as Gloucester, and there met the broad-gauge Bristol and Gloucester. In the last chapter, dealing with the development of the Great Western, it is pointed out how Gloucester became the pivotal point around which was fought the "Battle of the Gauges." It was quite clear that the Birmingham and Gloucester could not long remain independent, with powerful standard-gauge neighbours to the north-east, and the equally powerful broad-gauge Great Western to the south-west. The Midland secured this link in 1846, but it was not until 1854 that it was enabled to run standard-gauge trains through to Bristol.

In the late forties the Midland bought up the Leeds and Bradford, opened in July, 1846, thereby consolidating its position in the Yorkshire woollen towns and reaching Skipton. In 1852 it extended still farther to the north of Skipton by absorbing the North Western—to be distinguished from the London and North Western—opened to Morecambe in 1848, by passing through Settle and thus obtained access to the Irish Sea. Although not traversing a densely populated district, this connection proved of great importance to the Midland at a later date, since it enabled them to offer a route to the Isle of Man and Ireland through Heysham, and by means of Tebay offered an alternative route to Scotland independent of the North Eastern through York. As will be seen later on the Midland built its own line into Carlisle, and so freed itself of both the East and West Coast routes. The same year very nearly witnessed the formation of the English lines of the London, Midland, and Scottish, as plans had

been made to combine the Midland and the London and North Western in that year. By this time, however, public opinion had veered round to a policy of opposition with regard to railway amalgamations. In part this was probably due to the fact that railways appeared to be verging on monopolies as a result of their successful fights against the older transport systems of roads and canals.

By reference to a map it will be noticed that the Midland Railway was still far from reaching London in the early fifties, and handed most of its London traffic over to the London and North Western at Rugby. After the original amalgamation plan with the London and North Western had fallen through, a further plan to amalgamate with the Great Northern Railway was proposed, and this plan was so amended by the time it reached Parliament as to include the London and North Western also, but the House of Commons had now developed a policy of assisting competition, and the Bill was rejected.

Looking back after a period of seventy-three years little surprise is likely to be expressed at this decision. The policy of *laissez-faire* was still dominant, and for the development of the country it is doubtful if placing the two main lines to the north under a single management would have been adjudged as the wisest policy. In modern times with strong road competition, and the probability of competitive air services in the near future, railway monopolies may be successfully regulated and probably lead to increased efficiency through standardization; by 1853 regulatory policies were still unformed and undetermined.

The failure of these amalgamation proposals made inevitable the Midland's extension to London, but temporarily it constructed a line to Hitchin through Bedford from Leicester, which was open by 1858. By handing over London traffic to the Great Northern at Hitchin, it kept for itself a longer haul than its route through Rugby yielded. Consequently Midland trains ran into King's Cross from 1858. Such a method of working can only be solved with success by the system

of union terminals as employed in the United States, which ensures the neutral operation of terminal working and hence equal chances to all users of the facilities provided.

By 1862 congestion on the Great Northern main line had become so acute that the Midland determined to build their own main line into London and obtained the Act for this southern extension in 1867. Southward from Bedford a new trunk line was constructed with four tracks, terminating under the magnificent span of St. Pancras Station, a close neighbour to its older rival of King's Cross. Ideally situated to bring mineral traffic to London, two sets of metals are to-day kept almost exclusively for mineral and general freight traffic. The former is classified for the various London depots, docks, and transfer stations of the other railways, at Brent sidings, near Hendon, where are collected the empty wagons, formed into eighty wagon trains, and despatched on time-table workings to Toton, on the Erewash Valley section, where exists the most important marshalling yard for loaded and empty mineral wagons in England.

Like several other London termini, the frontage of St. Pancras Station is a railway hotel, the latter being built to the design of Sir Gilbert Scott in the Gothic style. St. Pancras passenger station, Somers Town freight station which adjoins it, and the connecting line with the Metropolitan Railway to Moorgate Street in the City, were opened in 1868, the year following the Midland's arrival in Manchester. Since then, Midland trains have run through from Manchester to Liverpool (Central Station), over the Cheshire Lines Committee, a joint line, the history of which is dealt with under the development of the London and North Eastern Railway, since it belongs to the extent of two-thirds to that Company.

With its Liverpool and London extensions the Midland had thereby become an important rival to the London and North Western Railway for the Mersey side to London freight traffic, although it possessed the longer route and more heavily graded line, but it was never able to gain

much of the London to Liverpool express passenger traffic. It was a strong competitor to the London and North Western Railway for the London to Manchester business, and what it lacked in speed it endeavoured to make up in added comfort and high quality of service. To the Midland and the Great Eastern Railways is due the honour of having first permitted third-class passengers to travel on all their trains ; this event of great importance in the annals of passenger-train travel took place in 1872.

Though George Hudson had suffered eclipse by the fifties it will be seen that his policy had still survived, and the Midland was not satisfied with reaching Morecambe, Liverpool, and London. In 1869 it reached Wales, working its trains over the Hereford, Hay, and Brecon, and in 1876 it acquired the Swansea Vale Railway, entirely detached from its own system, which it reached through Hereford and Brecon, running its trains over the Neath and Brecon, now part of the Great Western Railway.

In the same way that it had suffered from running into King's Cross over the Great Northern, so the Midland also suffered from lack of its own track into Carlisle, the Border city, and, during the sixties, it set about building an independent line northwards from Settle. This new stretch of railway, running through very sparsely populated country, was opened by 1876 and formed the connecting link of the third great trunk line from London to Scotland. The Act for this northern extension had been obtained in 1866, but in 1869 Parliament was applied to for power to abandon this section. Fortunately for the Midland this power was not granted, and soon afterwards the financial outlook brightened sufficiently to allow of the line's construction.

The development of the Midland owed much to Sir James Allport, at one time Manager of the York, Newcastle, and Berwick, and later General Manager of the Manchester, Sheffield, and Lincolnshire. As General Manager of the Midland from the fifties to the end of the seventies, he was largely responsible for the extensions above outlined, as well as for its access to Bournemouth

by 1875, over the Somerset and Dorset,[1] jointly owned with the London and South Western, and by 1880 to York over metals owned jointly with the North Eastern Railway. By means of a joint line with the Great Northern it reached Norwich, Cromer, and Yarmouth, during the nineties, thus affording the Midland towns and cities, such as Northampton, Nottingham, and Derby, direct and in some cases alternative routes to East Anglian coast resorts.

From 1880 to the end of the century the Midland occupied itself mainly with increasing its existing facilities rather than the construction of new lines, a policy which was adopted by the majority of other British railways at that time. The increasing weight of trains, improvement of stations, the general growth of industry, trade, and population, necessitated such a policy, and no line achieved a higher reputation for comfort and good service than did the Midland during this period.

Not satisfied with a network stretching from Carlisle and York to London and Bristol, it developed Heysham harbour near Morecambe, and from September 1st, 1904, ran a service of fast steamers to the Isle of Man and Belfast, after having absorbed in 1903 the Belfast and Northern Counties of Ireland of 5ft. 3in. gauge. In 1906 it still further extended its Irish activities by absorbing jointly with the Great Northern of Ireland, the County Donegal lines, now known as the County Donegal Joint, the longest narrow-gauge line in Great Britain and Northern Ireland.

A further twentieth-century absorption by the Midland Railway was that of the London, Tilbury, and Southend line. Originally, this railway was sponsored by the London and Blackwall and the Eastern Counties Railways. The Eastern Counties became the Great Eastern Railway in 1862, and obtained a 999 years' lease of the London and Blackwall. Representatives of these lines sat on the Board of the London, Tilbury, and Southend Railway which had, consequently for many years a close con-

[1] The history of this railway appears in connection with that of the London and South Western Railway.

nection with the Eastern Counties, but a separate Company was formed in 1862 when the Eastern Counties itself was absorbed in the Great Eastern system.

The Act for the construction of the railway from a junction with the Eastern Counties near Ilford to Tilbury received the Royal Assent in June, 1852, and that section was opened two years later. The same year saw extensions to Stanford-le-Hope and Thameshaven. The railway was opened throughout to Southend in 1856. Its London terminus was Fenchurch Street, opened in 1841, which it reached by perpetual running powers granted in 1856, over the original London and Blackwall Railway. The same year the construction of a short cut from Barking to Stepney, which permitted the avoidance of Stratford, was carried out.

The line was leased to contractors from 1854 to 1875, and during that period no third-class passengers were carried, though the second-class fares were extremely low. On the London, Tilbury, and Southend taking over the working in 1875, third-class carriages were put into service, although for two years these were hired from the Great Eastern as was the locomotive power until 1880.

During the eighties freedom was obtained from the controlling influences of the Great Eastern and the London and Blackwall Railways, and extensions were authorized to Romford, Whitechapel, and Shoeburyness, in addition to a new direct line through Upminster which avoided Tilbury. During the nineties an important connecting link was made between the Midland Railway at Tottenham and the London, Tilbury, and Southend at Forest Gate. Known as the Tottenham and Forest Gate Railway, this joint line permitted the Midland to run through trains from St. Pancras to Southend and boat trains to Tilbury Docks. It was the building of this line that finally induced the Midland to acquire the London, Tilbury, and Southend, and the results have been important in recent years because the London, Midland, and Scottish have obtained a strong position in what might have been a wholly London and North Eastern area. It has also given the L.M.S.R. a much

greater interest in the Port of London through their interests at Tilbury than they would otherwise have had.

In 1902 a connecting spur line was made jointly with the District Railway, known as the Whitechapel and Bow, which permitted the running of through trains between Southend and Ealing. During the latter part of the journey, District Railway electric locomotives are employed.

The London, Tilbury, and Southend Railway was noteworthy for two features : the first, its dense residential passenger traffic, mainly to Southend which it reached through Upminster, a distance of 36 miles, or through Tilbury, 8 miles longer ; and secondly, its important connections with Thames shipping at Tilbury. Looking back over a period of almost a century, it is difficult to understand why the great main line to the eastern counties carefully avoided any connection with London's docks. There seems, however, good ground for supposing that this occurred by mischance rather than by design, for Rennie, who originally backed the London and Blackwall, essentially a line built to tap the traffic of the docks as they were then, hoped to make this the starting-point of his main route to East Anglia. The Eastern Counties scheme, however, won the day and the London and Blackwall was left as a local line of commercial interest only. The Great Eastern, as successor to the Eastern Counties, saw the importance of this dock line in the sixties, but was satisfied with obtaining a perpetual lease of it. With the growth of the Port of London, the London and Blackwall line, though it does connect with the Port of London Authorities' lines, has been left too much to the west ; the main improvements of recent years have centred nearer Tilbury with the result that the London, Tilbury, and Southend line is likely in the future to reap the greatest benefit.

It is a matter for surprise that those in charge of the Great Eastern policy permitted the Midland to acquire the small line situated at the strategic point in Great Eastern territory. Besides catering for the Tilbury Docks traffic it acts as a powerful competitor for the valuable

holiday and season ticket traffic to Southend. From its opening, the line has run ferry services from Tilbury to Gravesend.

This extension of the Midland Railway has proved extremely useful to the combined L.M.S.R. as a means of developing a direct route between the towns and cities in the Midlands and the north with Northern France, Alsace-Lorraine, and Switzerland, by way of Tilbury and Dunkirk.

Table IV, p. 117, is sufficient to give a general impression of the growth of the Midland Railway over a period of sixty years.

The Lancashire and Yorkshire Railway

The ancestry of the Lancashire and Yorkshire Railway, now an important part of the L.M.S.R., can be traced back to the Manchester, Bolton, and Bury Canal Navigation and Railway, whose railway construction was permitted by an Act of 1831, and which was opened in May, 1838. Three years later traffic was being run over the whole distance between Normanton and Manchester on the Manchester and Leeds Railway, a scheme which had been originally suggested as early as 1825.

Alexander Nimmo [1] interested himself in both these lines, though George Stephenson appears to have been the engineer for the Manchester and Leeds, which proved a difficult engineering work, and required heavy quarrying as well as the construction of several tunnels and skew bridges, which are familiar to those who have made a study of old railway prints.

The Manchester and Leeds scheme was a direct result of the success of the Liverpool and Manchester Railway, for the Board of Directors first met in 1830 and pointing to the good results of the earlier railway drew up a scheme for their proposed line to start by a junction with the Liverpool and Manchester and proceed up the valley of the Calder to Sowerby Bridge. The resulting Bill was defeated through the opposition of the Canal interests. In 1835 a new Bill was presented to Parliament and,

[1] See Chapter II.

under the new plan, the line was to terminate at Normanton. From Normanton to Leeds the line was to be given running powers over the North Midland. Royal Assent was obtained for the Act of Incorporation in 1836, and the capital authorized amounted to £1,000,000 of stock and a loan of £433,000. Intended to serve such densely populated and rapidly growing industrial communities as Rochdale, Todmorden, Brighouse, at that time the station for Bradford, Dewsbury, and Wakefield, the 50½ miles were double-tracked from the first, as was the case with the Liverpool and Manchester Railway.

Construction was commenced in 1837, and two years after the Royal Assent was given to the Act authorizing the construction of branches to Halifax and Oldham, and the raising of the extra capital necessary. The line was opened throughout on March 1st, 1841, although the Manchester terminus was then at Oldham Road, not at the later terminus of Hunts Bank, opened in 1844, and now known as Victoria, which adjoins Manchester Exchange, the site of the old Liverpool and Manchester terminus. The Victoria Station was, however, from its opening in 1844, a joint station of the two railways, though the Liverpool and Manchester used the standard 4ft. 8½in. gauge, and the Manchester and Leeds a 4ft. 9in. Since 1924 the L.M.S.R. have so reconstructed these two stations of Manchester, Victoria (Lancashire and Yorkshire as successors to the Manchester and Leeds), and Manchester, Exchange (London and North Western as successors to the Liverpool and Manchester), that they are now practically one station.

Many important branches have since been added to the main stem, the earliest of which was that to Halifax in 1844. The junction at Normanton with the York and North Midland, later a part of the North Eastern Railway, was of the greatest importance, for it placed Liverpool, Manchester, Birmingham, and London in touch with York, through the York and North Midland. Thus by the middle of the forties rail communication existed between Newcastle and London through York, Normanton and Manchester over the York and North Midland,

Manchester and Leeds, Liverpool and Manchester, and Manchester and Birmingham Railways, and thence via the Grand Junction and London and Birmingham.

There was an alternative route through Derby, Leicester, and Rugby, but terminating in the London and Birmingham Station at Euston Grove in either case. It will be seen that the Manchester and Leeds was an important link in the chain of railway communication from north to south, but it was also an important link for east to west traffic, since by means of the Hull and Selby, and York and Selby, both of which lines were later part of the North Eastern Railway, the North Sea port of Kingston-upon-Hull was placed in direct rail communication with the great Atlantic port of Liverpool. In this way the Pennine Range, separating Lancashire from Yorkshire, was overcome and the industrial towns of both counties developed rapidly as a result of the betterment in transport facilities. The steam power which had been responsible for the railway era was also responsible for bringing the woollen mills of Yorkshire and the cotton mills of Lancashire down from their isolated valleys, chosen for their water power, to their new positions near coal supplies. The increasing trade provided abundant traffic for the Manchester and Leeds, which amalgamated with the Manchester and Bolton in 1846. In 1847 its title was changed to the more appropriate one of the Lancashire and Yorkshire Railway, but not before it had absorbed several lines in both those counties. One of these was the West Riding Union Railway, incorporated in 1846 and immediately transferred to the Manchester and Leeds.

The next great extensions of the Lancashire and Yorkshire were in Lancashire rather than in Yorkshire. Although earlier attempts to obtain an outlet to Liverpool free of the Liverpool and Manchester Railway had failed, this was achieved in 1846 by the acquisition of the Liverpool and Bury Railway incorporated in 1845. By the fifties the network of the Lancashire and Yorkshire lines between the cotton towns of Preston, Burnley, Blackburn, and Accrington had been built up by the

construction of the Blackburn and Preston, whose Act dated back to 1844, and the Manchester, Bury, and Rossendale of the same date. These two lines had been known as the East Lancashire after their amalgamation in 1846. The extensions to Colne and Burnley had been authorized by an Act of 1845, that to Accrington by an Act of 1846. The East Lancashire amalgamated with the Lancashire and Yorkshire Railway in 1859, and two other smaller lines have helped to build up the Lancashire and Yorkshire in the country of the red rose. These two lines were the Liverpool, Ormskirk, and Preston Railway authorized in 1846 to connect Liverpool to the Blackburn and Preston Railway ; and the West Lancashire Railway, though the latter was not absorbed until 1897.

Beyond Preston the Lancashire and Yorkshire were already endeavouring to reach Fleetwood, where they have since built up a big fish traffic, by means of the joint Preston and Wyre line, whilst in Yorkshire the Huddersfield and Sheffield, and Wakefield lines consolidated their position in the woollen towns. Through the promotion of the Wakefield, Pontefract, and Goole in the middle forties, they hoped to get control of the North Sea port. The Lancashire and Yorkshire in 1905 started an exceedingly important trade with the Continental ports of Amsterdam, Antwerp, Hamburg, and Rotterdam from Goole, and that port celebrated its centenary in 1926.

This south-easterly extension from their original territory was also in later years to be the cause of bringing the Lancashire and Yorkshire much valuable traffic, for in connection with it have since been constructed the various joint lines which tap the South Yorkshire coalfield.

Thus, prior to its absorption by the London and North Western, and later by the L.M.S.R., the Lancashire and Yorkshire possessed a network of lines stretching from Liverpool, Southport, and Fleetwood, on the west to Goole, on the east, with running powers into York over the North Eastern, and Doncaster over the Great Northern. On the south it reached Penistone on the Great Central Railway, and in the north it terminated at Hellifield on the Midland main line to Scotland.

A difficult line to operate owing to great density of traffic, both passenger and freight, and heavy gradients on much of its mileage, it was forced as early as 1904 and 1906 to electrify some of its suburban lines in the regions of the Liverpool and Manchester. An index to its rapid growth in the later nineteenth century may be seen by the growth of its rolling stock requirements, for by 1860 it owned about 350 locomotives, in 1880 this number had increased to about 800, whilst in 1921 the total had grown to 1,650. Unfortunately figures as to average tractive force are not available. Its early locomotives were built at Miles Platting in Manchester; later new shops were completed at Horwich, where a notable scheme for the housing of the employees was carried out.

The rise of the Lancashire and Yorkshire was bound up with the rise in prosperity of the industrial north, and to its efficiency the country owed much as assisting the import and export trades, especially with regard to cotton and woollen products as well as the heavier industries of iron, coal, and steel.

Table IV, p. 117, is sufficient to give a general impression of the growth of the Lancashire and Yorkshire Railway over a period of sixty years.

The Caledonian Railway

The lineage of this Scottish railway traces to the Garnkirk and Glasgow Railway in the west of Scotland, and in the east to the Dundee and Newtyle, which in 1846 became leased to the Dundee and Perth. Both of these lines received their Acts of Incorporation in 1826 and have been mentioned in an earlier chapter dealing with the birth of the railways.

Closely connected with the Glasgow and Garnkirk was the line from Wishaw to Coltness opened first in 1833, but the first portion of the Caledonian and Clydesdale Junction Railway was the section from Carlisle to Glasgow, for which the Act was obtained on July 1st, 1845, authorizing 136 route miles. It was opened in September, 1847, as far as Beattock, Thomas Brassey being the contractor, and the legal charges amounting to £75,000. This line

was surveyed by Locke and was practically the northern extension of the Lancaster and Carlisle, though behind the whole plan was the more important Grand Junction. Locke appears to have been by no means keen on the route over Beattock which has created operating problems for the Caledonian ever since. It had, however, been found impossible to avoid heavy gradients over the Shap and Tebay summits south of Carlisle, and if they could be ascended successfully and descended with safety, there was no reason why Beattock should not be equally possible.

From Carstairs a branch was constructed to Edinburgh, while the Castlecary branch connected it with the Scottish Central Railway, both branches being opened in 1848. The Scottish Central ran from Greenhill to Perth. This line, together with the Scottish Midland, had been surveyed by Locke and constructed by Brassey, as was also the Caledonian and Clydesdale Junction Railway. By 1845 all these lines were under construction and the Caledonian acquired the Garnkirk and Glasgow and the Pollock and Govan Railways in 1846.

By 1850 the small Wishaw and Coltness had become part of the Caledonian system and a close connection had been built up with the Scottish North Eastern, successor in 1856 to the Scottish Midland and other eastern Scottish lines centring on Newtyle, Forfar, and Aberdeen. The Scottish Central, besides forming the link between the Caledonian and Scottish North Eastern and thereby receiving much traffic for which it had no need to canvas, enlarged itself by acquiring the Dundee and Perth Railway in 1863. But the Scottish Central itself as well as a branch to Dumfries was absorbed by the Caledonian in 1865, and this appears to have led to the absorption in the following year of the Scottish North Eastern and several other less important lines. Until the end of 1869 certain Caledonian trains used their rival's Queen Street terminus. Having taken over all the independent railways within its immediate reach, the Caledonian turned its attention to water transport on inland waterways, and bought up the Forth and Clyde Canal in 1867.

The main formation of the Caledonian was, then, complete by 1870, like its southern partner of the West Coast route, the London and North Western Railway, but in the case of the former many small branches and connecting lines had still to be made, one of the most interesting of which, though not for the density of its traffic, was the line up to Oban. The Caledonian had early acquired the Glasgow, Paisley, and Greenock Railway dating back to 1841, while by the construction of the Lanarkshire and Ayrshire the Caledonian had obtained an entry into Ardrossan by 1891, two years after its arrival at Gourock.

It is impossible to pass the last decade of the nineteenth century without mentioning the London to Aberdeen Races of 1893–1895, by the West and East Coast routes to Scotland. On August 21st of the latter year, the West Coast partners succeeded in covering the 540 miles in 512 minutes, thus improving by eight minutes on the previous night's record by the East Coast route totalling 523½ miles. The first famous races of the competitive coast routes to Edinburgh had taken place in 1888, in which year the East Coast route commenced to carry third-class passengers from London to Edinburgh in nine hours, which resulted in alternative cutting of time by both routes.

Like its great rival the North British Railway, the Caledonian was greatly interested in ports and the more especially where coal shipping took place. The Forth and Clyde Canal brought with it the harbours of Bowling and Grangemouth, while the port at Alloa had been brought under Caledonian sway through acquisition of the Scottish Central.

The Caledonian Railway owned a share of the Portpatrick and Wigtownshire Railways from Castle Douglas to Stranraer with a branch to Whithorn. Really in Glasgow and South Western territory, this line was important as it formed a link in the Stranraer to Larne route to Northern Ireland, which gives the shortest sea passage on that route. The railway from Dumfries to Stranraer was opened in 1861 and ten years later the cross

channel service was established by the Larne Steamboat Company.

Table IV, p. 118, is sufficient to give a general impression of the growth of the Caledonian Railway over a period of sixty years.

The Glasgow and South Western Railway

When describing the birth of the British railway system in an earlier chapter [1] mention was made of the Kilmarnock and Troon. Like so many other early railways, this short line was built to render more easy the shipment of coal, in this case from the collieries near Kilmarnock to the port of Troon. A further line of the same description was the Ardrossan Railway which had been built in connection with the Glasgow, Paisley, and Johnstone Canal. It ran from Ardrossan to Kilwinning and had obtained its Act of Incorporation in 1827, but the early event of outstanding importance in the birth of what was later to be the Glasgow and South Western Railway was the Act of 1837, authorizing the construction of the Glasgow, Paisley, Kilmarnock, and Ayr Railway. This line, opened to Ayr in August, 1840, was so designed as to link up with the two earlier mineral lines. It received considerable assistance from the view which Locke, the engineer for the Caledonian, held concerning the possible desirability of using the so-called River Nith route between Carlisle and Glasgow in preference to the ascent over Beattock, for it can hardly be doubted that the promoters of the line conceived the idea of connecting with the English lines at the Border gateway of Carlisle. This southern portion was originally known as the Dumfries and Carlisle Railway, and was opened throughout in 1850, and although avoiding Beattock summit which has to be surmounted by its rival, the Caledonian, has itself gradients as steep as 1 in 100.

The same year saw the amalgamation of the Dumfries and Carlisle, and the Glasgow, Paisley, Kilmarnock, and Ayr Railways into the Glasgow and South Western, which then possessed about seventy locomotives. It entered

[1] Chapter II.

Carlisle by running powers over the Caledonian from Gretna. To the south-west it owns a quarter share of the Portpatrick and Wigtownshire Joint Railway mentioned in connection with the Caledonian Railway, thus providing it with a financial interest in the Stranraer and Larne route to Northern Ireland; a line opened from Girvan to Dunragit near Stranraer made possible the running of boat expresses. It reached the Firth of Clyde at Largs, Irvine, Ayr, and finally Girvan in 1860. Eastern branches reached Muirkirk, opened in 1848, and Darvel, while the shipbuilding centres of Greenock, at which it arrived in 1869, and Port Glasgow were also served by this railway. An alternative line jointly owned with the Caledonian Railway was opened between Glasgow and Kilmarnock through Barrhead in 1873. Twelve years later the Glasgow, Paisley, and Johnstone Canal was filled in and a railway constructed on its old bed, a type of conversion which fifty years earlier had nearly taken place in the case of the line paralleling the Manchester, Bolton and Bury Canal Navigation.

The Glasgow and South Western was a line mainly of local interest, and was fortunate enough to possess to a large extent a rail monopoly area. For two of its sources of revenue, however, it was forced to fight doughtily, namely, its Firth of Clyde steamship services, and its share of the through traffic to Carlisle and the south. To obtain its fair share in the latter it entered into close working agreement with the Midland Railway, and as a result through expresses were run from Glasgow to and from London (St. Pancras). This close working with the Midland dates back to the sixties, when the West Coast partners, the Caledonian and the London and North Western, were desirous of excluding the Midland from entering into competition with them for the London to Glasgow traffic, because the Midland at that time was building its Settle and Carlisle section. The Caledonian attempted to acquire the Glasgow and South Western, but finally failed, although they successfully prevented its amalgamation with the Midland. The Glasgow terminus was at St. Enoch, opened in 1876, and, like its

Caledonian and North British rivals, it owned a first-rate terminus hotel adjoining the station.

Passing through an industrial area in the Glasgow district the line had always paid considerable attention to freight traffic, and its College Freight Station at Glasgow was amongst the largest in the country ; whilst serving shipbuilding centres such as Govan, Renfrew, Port Glasgow, and Greenock, the problems it was set in the movement of heavy cartage and out of gauge machinery were by no means insignificant. Its locomotive workshops were at Kilmarnock and were opened in 1856 when the railway only owned just over one hundred engines ; in 1922 this number had risen to 450, or almost one per route mile.

For many years almost 50 per cent. of the railway's gross revenue has come from passenger train traffic, although in the sixties only 33 per cent. was derived from this source. Including its share of joint lines the Glasgow and South Western's route mileage increased from 257 miles in 1870 to 493 in 1922, its issued capital amounted to over £19,000,000 at the beginning of that year, and its capital expenditure to rather more than £20,000,000. The latter figure shows that the capital expenditure per route mile, of which 320 were single tracked, was approximately £40,000. Financially it generally succeeded in earning between 3½ per cent. and 5 per cent. on its ordinary stock.

Lastly reference should be made to its ownership of Ayr and Troon Harbours each enclosing a water area of well over 30 acres, and its Firth of Clyde steamship services from Greenock and the longer services run from Ardrossan and Troon.

Table IV, p. 119, is sufficient to give a general impression of the growth of the Glasgow and South Western Railway over a period of sixty years.

The Highland Railway

The northernmost constituent Company which went to the formation of the London, Midland, and Scottish Railway was the Highland Railway. Travelling over an

area with little population it was not to be expected that railways, costly to construct and requiring dense traffic to be highly profitable, should appear in the Highlands of Scotland at an early date.

In 1854 an Act was passed authorizing the construction of a line between Inverness and Nairn, 15 miles long, which was finally opened on November 5th, 1855, and was followed the next year by the opening of the Perth and Dunkeld, authorized in 1854. To Nairn a few years later was opened a line from Keith, in 1858, and the amalgamation of these two Nairn lines in 1861 was known as the Inverness and Aberdeen Junction Railway, which in 1865 acquired the Perth and Dunkeld, opened in 1863. The connecting line from Forres on the Inverness and Aberdeen to Dunkeld on the Perth and Dunkeld was known as the Inverness and Perth Junction Railway, and was opened in 1863. Two years later the amalgamated Company changed its title to the Highland Railway.

The Highland Railway prior to its absorption in the London, Midland, and Scottish Railway possessed considerable mileage north of Inverness. Of these lines the stretch from Inverness to Bonar Bridge had been built by the Ross-shire Railway incorporated in 1860, and opened throughout by 1864, while the Sutherland Railway incorporated in 1865 acted as a northern extension of this line from Bonar Bridge to Golspie and was opened in 1868.

The Dingwall and Skye Railway, authorized in 1865, which crossed Scotland from Cromarty Firth to the Kyle of Lochalsh, was opened to Strome Ferry in 1870, but did not reach the Kyle of Lochalsh until 1897, and was absorbed by the Highland Railway in 1880. The extension from Golspie to Helmsdale was constructed by the Duke of Sutherland in 1871, and the northernmost extensions, built by the Sutherland and Caithness Railway, to Thurso and Wick were opened in 1874. These lines were taken over by the Highland in 1884. The 34 miles direct line from Aviemore to Inverness was opened on November 1st, 1898. Although the southern terminus of the Highland Railway is known as Perth, in reality it

only reached that city by running powers over the Caledonian Railway.

Of a route mileage of 506 miles, only 78 miles were double-tracked, due partly to the low density of population and partly to difficulties of widening. At the end of 1920 its capital expenditure totalled nearly £7,500,000, thus the capital per route mile was in the neighbourhood of £15,000, in spite of its large single-track mileage.

Two other comparatively small but important local lines became part of the London, Midland, and Scottish Railway system in 1923, namely the Furness and North Stafford Railways.

The Furness Railway, which possessed an ancient lineage, goes back to 1844, the date of its incorporation. Like the majority of the early British lines its main function was the carriage of mineral traffic from the local mines to Barrow, where the traffic was loaded into ships. The first portion of the line was opened in August, 1846, but it did not carry passengers until December of that year. Extensions to Whitehaven and Carnforth on the Lancaster and Carlisle were made as a result of the development of mineral and general merchandise traffic, while the passenger traffic was increased through the opening up of branches to Windermere and Coniston. Connection was made with the Midland Railway by a line from Carnforth to Wennington on the latter Company's system, while in the Whitehaven area the Furness owned jointly with the London and North Western the Whitehaven, Cleator and Egremont line.

At Barrow the Furness Railway developed an extensive dock system which totalled over 275 acres of water. The Furness Railway has worked for many years in close connection with the London and North Western Railway, and to a lesser degree with the Midland ; two-thirds of its line was double-tracked, whilst its main source of revenue on the freight side came from mineral traffic, 2,365,000 tons of which it handled in the heavy traffic year of 1920.

The North Staffordshire Railway was a line of

almost purely local importance, but its traffic was heavy and, like the Furness Railway, it could boast of a long history dating back to 1846. In that year Acts were passed authorizing the construction of the Churnet Valley, and Harecastle and Sandbach Railways. The Churnet Valley scheme was really the outcome of the disappointment shown by the Congleton supporters of the Manchester and Birmingham when they found that the latter did not intend to build its main line through Congleton.

In 1847 these lines combined to form the North Staffordshire Railway, which the same year acquired the Trent and Mersey Canal. At a later date the North Staffordshire absorbed the Potteries, Biddulph, and Congleton Railway of 1854, which had been opened to traffic in 1859. In 1865 an extension from Kidsgrove to Hanley was authorized which was opened in 1875. Several small lines have since been absorbed with the result that the North Staffordshire connected with the Great Western Railway at Market Drayton, and the London and North Western Railway at Macclesfield, Ashbourne, Colwich, Norton Bridge, and Crewe. Connections were also made with the Midland and the Staffordshire branch of the Great Northern Railway. From Macclesfield it owned jointly with the Great Central the line through Bollington to Marple.

Much earlier than the railway itself is the Trent and Mersey Canal which it owns, the earliest portion of which dates back to 1766. The Harecastle Tunnels on this canal, the first of which was opened in 1777, are noteworthy features. Through the older tunnel boats have quite recently been propelled by boatmen lying on their backs and pushing with their feet the sides or roof of the tunnel. Through the newer tunnel constructed by Telford in 1827, boats are propelled by an electric towage system.

The brief outline of the growth of the eight constituent companies of the London, Midland, and Scottish Railway is now completed and a few words will suffice to describe subsidiary Companies which were absorbed by the Rail-

TABLE IV.—Growth of the Chief Constituent Companies

	London and North Western.		
	1865.	1900.	1922.[1]
Capital expenditure (£)	40,482,731	111,426,253	197,905,293
Dividend on Ordinary Stock	6⅝%	6¼%	8½%
Length of line (route mileage)	1,274	1,937	2,708
Gross receipts (£)	6,276,879	13,897,503	42,479,676
Working expenses (£)	2,708,123	8,576,216	33,675,632
Rates and taxes (£)	85,828	425,808	1,530,053
Compensation (£)	80,666	172,046	207,740
National Insurance (£) (Health and Unemployed)	Nil	Nil	237,139
Ratio of working expenses to gross receipts (operating ratio)	43%	62%	79¾%
Passengers carried (excluding season tickets)	23,711,000	82,069,743	176,497,771
Average fare per mile in pence:			
(*a*) First class	1·95 [2]	[3]	[4]
(*b*) Parliamentary or third class	0·95	[3]	[4]
Season ticket holders	7,640	506,125[5]	169,177
General merchandise carried (tons)	4,383,927	9,650,047	16,317,499
Minerals carried (tons)	9,039,650	34,815,230	53,587,389

* See page 48 for qualifying remarks. [1] From the beginning of 1922 the Western Railway, and the combined figures are given under the latter railway. workmen's weekly tickets.

ways Act of 1921 in the so-called North Western, Midland, and West Scottish group. Amongst them were the Dundee and Newtyle Railway, which had contrived to keep its independence until then, though as previously described it had been many years since it had operated its own trains. Another was the Wirral Railway, a short line running into Birkenhead.

It is noteworthy that the absorption of the Stratford-on-Avon and Midland Junction Railway, successor to the East and West Junction Railway incorporated in 1864, which ran from Broom Junction on the Birmingham and Bristol section of the Midland Railway, to Olney on the Midland's Northampton branch gives the London, Midland and Scottish Railway a short cut to their otherwise circuitous route between London and Bristol, but this

OF THE LONDON, MIDLAND, AND SCOTTISH RAILWAY.*

MIDLAND.			LANCASHIRE AND YORKSHIRE.[1]	
1865.	1900.	1922.	1865.	1900.
26,103,256	104,187,019	130,474,448	21,114,172	54,108,777
6¾%	Pref. 2½% Def. 2¾%	Pref. 2½% Def. 6%	5⅞%	4⅜%
700	1,437	2,169	431	556
2,728,131	11,328,918	27,364,854	2,156,643	5,444,609
1,207,634	6,977,823	21,615,447	982,839	3,276,578
44,798	350,480	845,204	39,895	193,957
32,110	78,730	143,542	25,802	59,757
Nil	Nil	121,825	Nil	Nil
44%	62%	79%	46%	60%
11,179,051	51,932,911	92,052,317	20,708,647	64,665,969
2·22	[3]	[4]	1·46	[3]
0·96	[3]	[4]	0·74	[3]
2,645	38,443	97,467	5,077	39,246
3,903,628	17,028,232	9,201,552	3,151,809	6,421,746
5,352,299	23,908,879	39,643,459	3,888,487	15,374,141

Lancashire and Yorkshire Railway was amalgamated with the London and North
[2] Not express fares. [3] Not available. [4] See page 50. [5] Includes 404,594

67-mile line being single track almost throughout is not suitable for heavy traffic.

The Portpatrick and Wigtownshire Joint became automatically London, Midland, and Scottish, as in this Company were the four railways which previously owned the line in a joint capacity. Another small line of interest was the Maryport and Carlisle Railway since it was incorporated as early as 1837, and opened in 1845, George Stephenson being the engineer responsible for its construction. Built through flat country as a single line, it possessed no tunnel; the line was cheaply built and has been noteworthy for its success financially, it paid as high a dividend as 13 per cent. in 1873. Doubled throughout its 28 miles by payments from revenue, the total capital expenditure for its 43 route miles was only

TABLE IV.—Growth of the Chief Constituent Companies

	Caledonian Railway.		
	1865.	1900.	1922.
Capital expenditure (£)	14,797,406	52,844,027	56,305,498
Dividend on Ordinary Stock	7⅛%	Pref. 3% Def. 1%	5⅜%
Length of line (route mileage)	494	939	1,114
Gross receipts (£)	1,432,475	4,486,721	9,082,938
Working expenses (£)	636,257	2,540,506	6,954,176
Rates and taxes (£)	19,620	115,605	254,719
Compensation (£)	13,689	47,570	32,522
National Insurance (£) (Health and Unemployed)	Nil	Nil	33,738
Ratio of working expenses to gross receipts (operating ratio)	44%	57%	77%
Passengers carried (excluding season tickets)	6,590,725	45,059,545	32,457,703
Average fare per mile in pence:			
(*a*) First class	1·21	[3]	[4]
(*b*) Parliamentary or third class	0·66	[3]	[4]
Season ticket holders	1,879	49,228	48,580
General merchandise carried (tons)	1,505,916	5,126,203	4,573,174
Minerals carried (tons)	5,226,275	22,274,954	17,125,624

* See page 48 for qualifying remarks. [3] Not available. [4] See page 50.

£930,000 up to December, 1920, though its total issued capital stock and debentures only amounted to £885,495. Its originating traffic tonnage amounted to 304,138 tons in that year.

Thus concludes the short summary of the development of the London, Midland, and Scottish Railway since 1840.

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OF THE LONDON, MIDLAND, AND SCOTTISH RAILWAY * (*cont.*).

GLASGOW AND SOUTH WESTERN RAILWAY.		
1865.	1900.	1922.
5,663,432	16,868,796	20,240,929
6½%	Pref. 2½% Def. 1⅜%	Pref. 2½% Def. 3%
254	399	493
554,313	1,706,378	3,554,184
248,958	1,050,328	2,909,853
10,142	49,197	109,578
2,791	7,659	15,519
Nil	Nil	13,308
45%	62%	82%
2,626,783	17,899,191	16,629,078
1·82	3	4
0·90	3	4
592	6,600	12,686
394,073	1,671,035	1,581,622
2,963,391	6,553,726	6,104,966

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CHAPTER VI

LONDON AND NORTH EASTERN RAILWAY.
1840–1927

In an earlier chapter it has been seen that the nuclei of this railway were the Stockton and Darlington Railway in England, and the Monkland and Kirkintilloch and the Edinburgh and Dalkeith Railways in Scotland.

In June, 1838, had been opened the Newcastle and Carlisle Railway, an Act for which had been obtained in 1829; it was the first railway to connect the east coast with the west coast, and was in touch with water-borne traffic by canal at Carlisle, and Tyne River traffic at Newcastle. The same year—namely, 1838—had also seen the opening of the Brandling Junction, and the Newcastle and North Shields Railways, one following the south bank and the other the north bank of the Tyne. The former was important, as it gave the Newcastle and Carlisle access to deep water.

In 1840 the Leeds and Selby Railway, opened in 1834, was still the southernmost line of the present London and North Eastern Railway then opened for traffic, but on July 1st, 1840, the Hull and Selby was opened, a Bill for which had received Royal Assent in 1836; thus the east and west links were rapidly being forged. In 1843 the line very nearly amalgamated with the Manchester and Leeds, but the proposal fell through,[1] and in 1845 it was leased to the York and North Midland, and was finally acquired by the North Eastern Railway in 1872.

It will, perhaps, be advisable to adopt the same system of tracing the growth of this railway that was adopted in the previous chapters in the case of the S.R. and the

[1] It is of interest to contemplate the comparative effects on Hull and Goole if this amalgamation had actually taken place.

L.M.S.R., namely, to trace briefly the growth of the various constituent Companies which, as a result of the Railways Act of 1921, were amalgamated to form the L.N.E.R. at the beginning of 1923.

North Eastern Railway

Taking first, then, the growth of the North Eastern Railway, the much-enlarged successor of the Stockton and Darlington Railway. During the thirties York, jealous of the progress of younger towns as a result of becoming railway termini, had been anxious to crown its ancient glories by increased commercial prosperity, and to be connected by railway with other important Yorkshire trade centres. A citizen of York, George Hudson (1800–1871), at a later date known as the "Railway King," had especially interested himself in the project, and became, as a consequence, chairman of the proposed York and North Midland. Largely as a result of Hudson's forceful aid and financial assistance the Act for this railway obtained the Royal Assent on June 21st, 1836. This 24½-mile main line connected York with Normanton where a junction was made with the North Midland Railway. Both the North Midland and the York and North Midland were opened on July 1st, 1840, thus inaugurating an all-rail route to London from York through Derby and Rugby on the London and Birmingham. Connection was also made with the Leeds and Selby at Sherburn. In 1844 the York and North Midland obtained an Act to acquire the Leeds and Selby, and the same year was authorized to build an extension from York to Scarborough. The following year it reached Filey and purchased the Whitby and Pickering. In 1846 it opened a line to Bridlington and started to construct a railway from York to Leeds. A month later it obtained permission to lease or acquire the Hull and Selby, thus consolidating its already strong position in the East Riding; in 1848 the railway was opened from Church Fenton to Harrogate.

From 1840 the York and North Midland ran trains jointly with the North Midland into Leeds, a fact which

has been of importance to the successors of both these lines. After paying good dividends for some years from its completion the effects of its numerous extensions during the years of the railway mania appear to have made themselves felt, and in 1849 only a small dividend on the ordinary shares could be paid, but it appears to have recovered sufficiently by 1851 to have been able to lease the East and West Yorkshire Company, dating back to 1846. This line connected the York, Newcastle, and Berwick with the Leeds and Thirsk, and the formation of the North Eastern Railway a few years later was materially assisted by this acquisition.

As early as 1843 long-distance rail and water excursions were run from Yorkshire towns via Hull to Leith and Edinburgh. York, even at that time looking forward to its future greatness as a transport centre, was not contented with one railway, and a committee of its citizens had blessed the Great North of England scheme, the object of which was the construction of a line from York northwards to the Tyne. It is not surprising that the Stephensons were responsible for the surveys of both this line, which was opened to Darlington in 1841, and the somewhat earlier York and North Midland. The great North of England involved no great engineering works, and to-day is looked upon as a line admirably suited for high speeds. Incidentally its presence had a remarkable effect on North Eastern policy, which at the end of the century specialized in heavy freight and mineral train loads. The example set by this policy has affected British railway operating principles considerably.

The line from Darlington to Newcastle was constructed by a separate Company, the Newcastle and Darlington Junction Railway, but its amalgamation with the Great North of England in 1846 served to form the York and Newcastle, which in 1847 took over its northern neighbour the Newcastle and Berwick, for which an Act had been passed in 1845. Unlike the York and Darlington, the Newcastle and Berwick required heavy engineering work, notably the High Level bridge at Newcastle, and the Border bridge, with its twenty-eight arches, at Berwick,

both of which to-day are memorials to the engineering ability of Robert Stephenson. The resulting York, Newcastle, and Berwick formed the backbone of the old North Eastern Railway, and it is easy to see that railway policy was far different by 1850 from what it had been in 1825. In the latter year the outlook was local, and the traffic to be relied on was also local; in fact, the conception was that of a mineral or freight railway which might carry passengers if they preferred that means of transport to the road coach. In 1850 the York, Newcastle, and Berwick was an attempt to tap long-distance travel, to give a regular service between Scotland and Northern England, and by means of the North Midland and London and Birmingham with their connecting lines to form an all-rail line between Edinburgh and London.

In 1854, by an Act dated July 31st, the York, Newcastle and Berwick, the York and North Midland, and the Leeds Northern, together became the North Eastern Railway with headquarters at York. At the same date the Malton and Driffield became part of the North Eastern Railway. The Leeds Northern had been previously known as the Leeds and Thirsk, an Act for which received Royal Assent in 1845.

The sixties were to see further additions to the North Eastern Railway, such as the branch to Beverley opened in 1865. It had absorbed in 1862 the Newcastle and Carlisle, a railway which, like the Greenwich line, had adopted right-hand running, and in the following year the enlarged Stockton and Darlington, thus consolidating its rail monopoly position which it retains as the North Eastern Area of the L.N.E.R. to-day. The North Eastern Railway forms an outstanding instance of a railway pursuing very progressive methods without the supposedly necessary spur of direct competition. Although it carried a certain amount of competitive traffic by reason of its being a link in the East Coast route to Scotland, the only element of competition, if one excludes that of the Hull and Barnsley on the extreme south of its territory, in its freight and mineral traffic was the competition of markets.

A great event in North Eastern Railway history occurred on January 2nd, 1871 ; this was the connection made at Shaftholme Junction, between Doncaster and Selby, with the Great Northern Railway, thus completing the East Coast route to Scotland. In 1922 the North Eastern Railway took over the Hull and Barnsley, an important local line connecting Hull with the Yorkshire coal-field. Incorporated in 1880 as the Hull, Barnsley and West Riding Junction Railway and Docks Company, this line was an effort of Hull citizens to obtain independent rail communication with the west. Mainly important for mineral traffic, it possessed a route of 66 miles and was opened for traffic in 1885, working the South Yorkshire after the latter's opening in 1894. At its western end it connected with the Midland, Lancashire and Yorkshire, and Great Central Railways. It also owned important dock facilities at Hull.

During the sixties the North Eastern adopted the system so conspicuously successful with the Great Western forty years later, namely building cut-offs to shorten its main line. Thus between 1868 and 1873 the line between Durham and Newcastle, known as the Team Valley, was brought into use, and three years later the present main line through Selby between Doncaster and York, until which time the old York and North Midland line through Church Fenton had been used. The Blyth and Tyne, one of the original Tyneside mineral lines, part of which dated back to 1840, was absorbed by the North Eastern in 1874 ; it was only in 1927 that one of the famous wooden viaducts on this railway at Seaton was replaced by a steel structure. The year 1879 saw the opening of the neighbouring Riverside line along the north bank of the Tyne, which carries a heavy traffic in connection with the shipbuilding and heavy industries when trade is good. At the southern end of the system the Swinton and Knottingley Joint line, reached through Pontefract, greatly strengthened the North Eastern's hold in the coal-field area which in recent years has developed so rapidly. Several small lines were absorbed during the next ten years, including the Scotswood, Newburn, and Wylam,

the last-named place famous for its connection with Hedley and Stephenson, and an important branch to Coldstream was opened in 1887. By acquisition of the railway from Seaham to Sunderland in 1900, the North Eastern obtained possession of important coal export traffic at Tyne Dock, which they have since developed even more largely at Dunston and West Dunston staithes on the Tyne above Newcastle. In many cases the coal wagons are brought down from the mines to the concentration yard of Stella Ghyll by rope-worked machines, the loaded wagons pulling up the empties.

A large part of the Newcastle suburban service was electrified on the third-rail system in 1903, and ten years later the overhead system was adopted for the Newport and Shildon freight line electrification.

The North Eastern Railway, though possessing large and important passenger traffic, yet gained most of its wealth from mineral traffic. The Northumberland and Durham coal-fields annually exported millions of tons of coal, mainly through the ports of Blyth, Dunston, Tyne Dock (South Shields), Sunderland, the Hartlepools, and Middlesbro'. The Yorkshire coal-field also exported much coal through Hull. Iron ore from the Cleveland district was the source of much revenue, though mainly for internal movement. The so-called heavy industries, such as iron, steel, and shipbuilding, are concentrated in the Tyneside area, and occur also at Leeds, Middlesbro', Stockton, Darlington, and other individual centres. Yorkshire, Durham, and Northumberland are also important agricultural counties, and to Scarborough, Saltburn, Whitley Bay, and Harrogate, the North Eastern was successful in attracting much holiday traffic. The main traffic was, however, that obtained from mining, engineering, and shipbuilding, with all their subsidiary trades, and it was the trade depression in these industries that caused the serious loss in revenue to the London and North Eastern during 1924 and 1925. If such a depression had occurred before the grouping, the result to the financial position of the North Eastern Railway would have been even more serious.

Table V, p. 148, is sufficient to give a general impression of the growth of the North Eastern Railway over a period of sixty years.

The Great Northern Railway

The southernmost partner in the East Coast route to Scotland was the Great Northern Railway, which obtained its Act on June 26th, 1846. The Great Northern scheme was really the result of several competitive schemes which had been attempted during the previous ten years, to provide rail communication between London and such important agricultural centres as Cambridge, Peterborough, Grantham, and Newark. Most of these competitive schemes made York their final goal, and construction of the line from London to that city was commenced in 1846.

Thomas Brassey, to whom previous reference has been made, undertook part of the construction as a contractor, but William Cubitt (1785–1861) was the engineer for the line, though Joseph Locke (1805–1860) appears to have been responsible for its survey and for the line of route. Construction was slow, partly due to engineering difficulties, and its first stretch of line from Great Grimsby to Louth was not open until 1848; in August, 1850, it reached Peterborough, which since 1845 had already possessed a devious railway route to Euston through Northampton and Blisworth. Two years later the line was opened from King's Cross, the London terminus, through Grantham and Retford to Doncaster, though much of the mileage had already been open for some months.

King's Cross Station attracted considerable attention when it was first built, and its design is distinctive even to-day, though much altered internally since 1852, when it consisted of an arrival and departure platform with over a dozen intermediate lines. As from its West Coast rival, Euston, the trains have a heavy gradient to negotiate immediately upon leaving the station, made worse by the slippery nature of the rails in the tunnels passed through on their way to Finsbury Park. Once past the summit at Potter's Bar, the gradients are not

severe, and the high speeds for which the Great Northern was, for many years, mainly famous, were made possible by the comparatively easy nature of its gradients, though before Grantham is reached there is a heavy bank to overcome.

Owing to financial stringency in 1847, it had not been possible to construct the most northerly section from Doncaster through Selby to York. In place of it a connecting loop was made with the Wakefield, Pontefract, and Goole. By running powers over the latter the Great Northern Railway reached Knottingley ; from Knottingley a further spur was constructed to the York and North Midland at Burton Salmon. Thus was formed the original East Coast route to Scotland, and from Doncaster the Great Northern trains for York ran through Knottingley and the York and North Midland section of the North Eastern until the latter completed their direct line in 1871 between Selby and Doncaster (Shaftholme Junction), previously mentioned in the history of the North Eastern Railway. In practice the Great Northern never reached its original goal of York, but as early as 1851 worked into Sheffield over the Manchester, Sheffield, and Lincolnshire. Competition for the London and Sheffield traffic appears to have been very severe in the fifties, and fares were reduced to extremely low levels.

Though the name, Great Northern, recalls to one's mind chiefly the main line from King's Cross to Doncaster, it is important to remember, as Professor Ripley has pointed out,[1] that it is difficult for any main line to earn a good revenue, if it is acting merely as a bridge without adequate feeding lines, and unless these feeding lines are well placed. The Great Northern had many feeding lines. One branch obtained in 1865 and consisting of the old West Yorkshire and the Leeds, Bradford, and Halifax Railways, stretched to Leeds and Bradford, by means of running powers until the construction of the Doncaster and Wakefield Joint line.

[1] *Geographical Limitations of Consolidated Systems*, 36th Annual Meeting, American Economic Association, Washington, D.C., December, 1923, William Z. Ripley.

Others stretched to Dewsbury and Keighley, and yet another to Grimsby through Lincoln and Boston, the last part of which was the line of the old East Lincolnshire, operated from its beginning in 1848 by the Great Northern, which opened the Horncastle line seven years later. A fourth one went to Stafford, a fifth to Nottingham, obtained by absorption in 1855; while further to the south was a branch to Cambridge. The Stafford entry was obtained as a result of the extension to Egginton in 1878 and the acquisition of the Stafford and Uttoxeter in 1881. The loop line through Lincoln was used as main line until 1852.

Attention should, perhaps, be drawn to the very competitive nature of the Nottingham and London traffic. Competitive routes were owned by the four great systems, the Midland, the Great Central, the Great Northern dating back to 1852, and the London and North Western Railways, the difference in distance between the shortest and the longest of these being quite small. As a result of the Railways Act of 1921 the competitors are narrowed down to two, the L.N.E.R. and the L.M.S.R., and presumably certain economies have resulted. This, however, is a typical case, of which there are many instances throughout the country, as, for example, from London to Edinburgh, where through traffic is truly competitive, but the trains *en route* serve different cities and different territories, which makes impossible the elimination of what are popularly supposed to be competitive services. The percentage of through passengers or tons of freight on such trains may not always be high.

Besides serving Nottingham the Great Northern Railway in 1883 reached Leicester, at that time a Midland preserve, but later situated on the Great Central's southward extension to London. By means of a line owned by the London and North Western Railway, between Bottesford Junction and Market Harborough, the Great Northern in 1879 obtained running powers into Northampton, but these powers have never been exercised to any large extent; the boot and shoe trade centre of Northampton was regarded for many years as purely

the sphere of influence of the London and North Western and the Midland Railways. In 1882 there was completed the Great Northern and Great Eastern Joint line northwards from March to Lincoln through Spalding.

The branch from Hitchin to Cambridge was originally authorized as far as Royston by the Act of the Royston and Hitchin Railway in 1846, the line being opened to Royston four years later, and operated by the Great Northern. In 1852 a junction was made with the then Eastern Counties at Shepreth, whence trains travelled over the latter's tracks to Cambridge, the whole of the Hitchin to Cambridge service for a time being worked by the Eastern Counties. The Great Northern, however, took over this service in 1866 and obtained at the same time running powers into Cambridge Station. A strongly competitive service between Cambridge and London was run by the Great Northern and Great Eastern Railways prior to the formation of the L.N.E.R., and on this line was built up at Letchworth a "Garden City," the first of its kind and an experiment which has been followed with more or less success in other localities, the neighbouring "Welwyn Garden City" being the most recent example. The Luton and St. Albans branches from Hatfield were opened in 1860 and 1865 respectively. Jointly with the Midland and the Great Central, the Great Northern owned the Cheshire Lines Committee, which gave it access to Liverpool, and jointly with the Midland it reached Norwich, Cromer, and Yarmouth (*v.* p. 130).

The Welwyn Viaduct and tunnel are two of the main engineering features on the southern section of the Great Northern main line, and formed a bottle-neck which would have been too expensive to widen to four tracks. The solution adopted to overcome this difficulty and source of considerable delay to freight and mineral traffic was the construction of the Cuffley-Stevenage loop, which, joining the older main line just north of Welwyn, gave the Great Northern an alternative route to London, and a four-track main line for nearly the whole distance to Peterborough, and many four-track stretches on to Grantham. The new loop, opened for freight traffic in

1918 and passenger traffic by 1924, passes through Hertford, previously served as regards the Great Northern by a branch opened in 1858.

A heavy passenger traffic was carried on the Great Northern from King's Cross to be handed over to the North Eastern Railway at York, the Great Northern locomotives running through to that city. In addition express services were run to Leeds, Bradford, Harrogate, Sheffield, Grimsby, Nottingham, and at certain periods to Manchester. A large suburban traffic has been dealt with at King's Cross since the seventies, during which time the various suburban lines were constructed. The Great Northern also obtained a fair share of tourist traffic at its coast resorts of Lincolnshire.

On the freight side it served the important and growing coal-mining area of South Yorkshire, Nottinghamshire, and Derbyshire, and brought a large tonnage of coal to London, both for consumption there and for handing over to the lines now forming the Southern Railway. The Great Northern had also a heavy agricultural traffic, of which no small part was its London vegetable traffic from the counties of Bedford, Huntingdon, and Lincolnshire.

By means of a line jointly owned with the Midland the Great Northern penetrated into Norfolk until it reached the coast at King's Lynn, Cromer, and Great Yarmouth, and possessed a terminal station in the county town of Norwich. Known from the nineties as the Midland and Great Northern Joint Railway, it was previously the Eastern and Midlands, a title adopted in January, 1883. The genesis of this railway was the Norwich and Spalding, the first section of which was opened in 1858, but never reached Norwich. The scheme was carried on by the Lynn and Sutton Bridge of 1861, and the Spalding and Bourne of 1862, which took over the lease of the Norwich and Spalding at the time of their amalgamation in 1877 under the name of the Midland and Eastern Railway. Upon the latter amalgamating with the Lynn and Fakenham, Peterborough, Wisbech, and Sutton Bridge, Yarmouth Union, and Yarmouth and North Norfolk

Railways in 1883, there was formed the Eastern and Midlands Railways above mentioned.

The Eastern and Midlands was taken over jointly by the Midland and Great Northern Railways in 1893. In conjunction with the Great Eastern, the Midland and Great Northern Joint has since built the Norfolk and Suffolk line, from North Walsham to Mundesley and Overstrand, as well as the Yarmouth Beach to Lowestoft section.

Table V, p. 146, is sufficient to give a general impression of the growth of the Great Northern over a period of sixty years.

The Great Central Railway

Another main constituent of the present London and North Eastern Railway was the Great Central Railway, the last of the northern main lines to reach London. Prior to the opening of its London extension, this line had been known for many years as the Manchester, Sheffield, and Lincolnshire, and its genesis was an Act of 1837 which provided for the construction of a railway between Sheffield and Manchester. It only reached the latter city, however, by a joint line with the Manchester and Birmingham, now part of the L.M.S.R., and used the Manchester and Birmingham's London Road terminus. Promoted originally as the Sheffield, Ashton-under-Lyne, and Manchester it appears to have met with little opposition, due to the difficult and costly engineering work ahead of such a line. Like its neighbour, the Great Northern, this Company first employed Joseph Locke (1805–1860) as its engineer, but the construction of the Manchester and Sheffield line proved a much harder task than that of the Great Northern, for which, at a later date, Cubitt had become engineer.

The construction of Woodhead Tunnel north of Sheffield, like Kilsby Tunnel on the London and Birmingham, proved such a difficult engineering feat that the line was not opened throughout until 1845, and even in more recent days its ventilation has had to be considerably improved. Soon after its opening, the Sheffield and Manchester,

which had started with a capital of £700,000, appears to have narrowly escaped being acquired by the Manchester and Birmingham or by the Midland, but instead itself amalgamated with the lines connecting Sheffield with Grimsby and Lincoln. This took place in 1847, and its title was changed to the Manchester, Sheffield, and Lincolnshire Railway. Here is another typical example of how the British railways, after being constructed purely as local lines, found it essential to link up with their connecting lines by amalgamation, thereby tending to obtain an increased length of haul and to strengthen their competitive positions. This policy is especially true of the Manchester, Sheffield, and Lincolnshire, better known as the Great Central, which name it adopted in 1897. It found itself hedged in by competitors and gradually consolidated its position by absorbing many local lines in various counties contiguous to its interest. In 1862 the Manchester, Sheffield, and Lincolnshire and the London and North Western Railways jointly leased the Oldham, Ashton, and Guide Bridge, which gave the former an entry into Oldham. Two years later the Manchester, Sheffield, and Lincolnshire leased the South Yorkshire, thus obtaining big interests in the coal-field of that area.

Although a strong competitor to the neighbouring Great Northern Railway in many areas, notably around Doncaster, Sheffield, and in North Lincolnshire, the Great Central as early as 1848 entered into traffic-working agreements with its rival. By means of these agreements, through trains were worked between Manchester and London over the Great Central and Great Northern railways, and during the sixties efforts were made to extend this service to Liverpool and obtain a through-freight route from the Humber to the Mersey. The Cheshire Lines system proved the means by which this was achieved, the Great Northern taking a share in the railway which runs from Manchester and Godley Junction to Liverpool and Southport [1] through Glazebrook. The

[1] The Cheshire Lines Committee extension to Southport was not opened until 1884.

Acts authorizing most of these lines received Royal Assent in 1866, and the previous year had seen the passing of the Cheshire Lines Act by which the Manchester, Sheffield, and Lincolnshire, and the Great Northern jointly obtained entry almost into Chester itself. In July, 1866, the Midland Railway joined in the partnership of the Cheshire Lines, while in the following year, 1867, an Act was passed incorporating the Cheshire Lines Committee as a separate entity.

Numerous small additions have been made since the sixties, but the main importance of the Cheshire Lines Committee, as it is known, is still to give an outlet to the Mersey to the L.N.E.R. as successor to the Great Northern and Great Central Railways. The Midland entry to Liverpool is not nowadays so important, because other sections of the L.M.S.R., namely, the London and North Western Railway, and the Lancashire and Yorkshire Railway, have been strongly entrenched there for many years, but its importance remains for the Great Central and Great Northern Railways, to-day part of the L.N.E.R., since through the Cheshire Lines Committee they obtained an entry to tidewater on the western coast of England. The Clyde, Carlisle and Mallaig are the only other areas where the L.N.E.R. impinges on the west coast. The warehouses possessed by the Cheshire Lines Committee, both in the North and South Docks at Liverpool, as well as the connecting lines with the Mersey Docks and Harbours Board Railways, placed them in a strong position to deal with traffic. The Great Central, through Connah's Quay and Chester, also obtained an entry into the Birkenhead dock system.

The Marple and New Mills line in the Peak District became part of the Manchester, Sheffield, and Lincolnshire in 1863, and jointly with the Great Northern, the Sheffield line acquired the West Riding and Grimsby Railway. Although owning coaching and wagon stock of its own the Cheshire Lines Committee does not possess its own locomotives, relying on the engine-power supplied by the parent companies.

The year 1871 saw the entry of the Manchester, Sheffield,

and Lincolnshire into Macclesfield by a joint line with the North Staffordshire Railway. At Chester the Great Central is found again, and nearby it absorbed the Wrexham, Mold, and Connah's Quay in 1905, which gave it an interest in the North Wales coal-field at Wrexham, and permitted it to reach the Wirral. Two years later, in 1907, it absorbed the Lancashire, Derbyshire, and East Coast Railway which was incorporated in 1891 and centred on Chesterfield, thereby securely entrenching its position on the Derbyshire and South Yorkshire coal-field area. During the twentieth century its position in this district has been still further strengthened by the construction of the South Yorkshire Joint line which it owned to the extent of a fifth. The Great Central's control of the Mansfield Railway authorized in 1910 and opened in 1916 has also proved of importance in view of the extension of coal-mining activities in that area.

After unsuccessful attempts in 1873 and 1891, it thrust its tentacles southwards, another evidence of desire to increase the length of haul, and made arrangements with the Metropolitan to run over the latter's Buckinghamshire extension line and enter the Metropolis through Neasden, with a terminus of its own at Marylebone next door to the Metropolitan Railway's junction at Baker Street. This latter step met with strong opposition from its future competitors, especially the Midland, since the Manchester, Sheffield, and Lincolnshire had planned its line from Sheffield through Nottingham and Leicester, both of which towns were served by fast express trains of the Midland Railway to and from St. Pancras (London). The Act permitting the Manchester, Sheffield, and Lincolnshire to come to London was passed in 1892, and the construction of the London extension was begun. Near Quainton Road a junction was made with the northern extension of the Metropolitan. The new route of the Great Central was opened in March, 1899, for passenger traffic, and has long been noted for the high speeds attained by some of the express trains operated over it. By no means easily graded the Great Central trains required high-class locomotive work, although the passen-

ger trains on this London extension have never reached the tare weight of the northern expresses from Euston and King's Cross. In April, 1906, the Great Central in conjunction with the Great Western opened an alternative route to London, authorized in 1899, which left the old main line at Grendon Underwood and after passing over the two Companies' joint line through Prince's Risborough and High Wycombe rejoined the old main line at Neasden.

Like all last comers entering into competition with rivals who had already consolidated their positions, the Great Central had perforce to adopt a very progressive policy to attract traffic from its competitors' lines. It is doubtful if those in charge of Great Central policy ever dared to hope that the extension could be financially successful if it relied purely on new traffic arising from the area it opened up. It is not surprising, therefore, to find that the Great Central extended its service to many activities, such as dock owning and steamship services. The latter, it is true, had been operated for several years prior to the opening of the London extension, and an efficient service was run from Grimsby and Immingham to the Continental ports of Antwerp, Rotterdam, and Hamburg. These North Sea services really date from 1852, when the railway-owned dock at Grimsby was opened, but were only railway operated after 1865 when the Hamburg service was started. As regards dock-owning, the Great Central, which possessed a considerable interest in the South Yorkshire coal-field, found it essential to better the facilities offered for the export of this coal traffic from the Humber. With that in mind, it set about the construction of the port of Immingham on the south bank of the Humber, and in connection therewith laid out the large coal-marshalling yard at Wath, built in 1907, which can deal with nearly 7,000 wagons per day. A further important centre for the coal-traffic distribution will be the large yard now under construction at Mansfield.

The Great Central could also lay claim to much credit for the growth of Grimsby itself, which has, of recent years, been one of the biggest fishing ports in the world.

Though most famous on account of its imports of fish, Grimsby, which was also served by the Great Northern Railway, plays an important rôle in the shipment of coal, which at this port in 1923 amounted to over 1,750,000 tons. In 1922 it handled imports, exports, and re-exports to the value of more than £28,576,500. Much timber is imported through Grimsby, arriving there from the Scandinavian countries and the Baltic ports. In 1860 this traffic was less than 80,000 tons, while in 1906 it was nearly 400,000 tons, and in 1922 the timber imported into Grimsby and Immingham amounted to 7 per cent. of the total imports of these ports, if measured by value.

The port of Immingham was planned by the Great Central Railway to act as an extension rather than a competitor to Grimsby, where extensions would have proved very costly. The construction was first begun in 1906 and it was opened in 1912, with an enclosed water area of about 45 acres, 170 miles of sidings and accommodation for nearly 17,000 wagons. Built largely for the shipment of coal, the wagons are raised by hoists, unlike the Tyne method of shipping from staiths. In the latter case, the coal is allowed to fall through doors in the floor of the wagon and reaches the hold of the ship by gravity. At Immingham, as in South Wales, the wagons used are fitted with end-doors and after being hoisted up the wagon is tipped to permit the coal to pass out at one end on to a shoot which feeds it into the hold of the ship. Immingham has dealt with over 3¼ million tons of coal in one year, and its capacity is somewhat over 5,000 tons per hour when all eight hoists are working.

In at least one further respect the Great Central was a noteworthy line. As the result of its peculiar geographical position, it was an essential link in through services, since its tentacles stretched northwards to Penistone, where it obtained touch with the Lancashire and Yorkshire; eastwards to Grimsby; north-westward to Liverpool; and southwards to London and Banbury, where it transferred traffic to and from the Great Western. It reached Banbury by a short branch line from Woodford and Hinton on its main line. Consequently, it became

famous for the cross-country journeys, a large part of the mileage of which was made over Great Central metals. The most noted of these were Newcastle to Bournemouth through York, Sheffield, and Oxford ; Liverpool (Cheshire Lines Committee) to Harwich and Yarmouth through Penistone, Retford, and Lincoln ; and the recent Aberdeen–Penzance service through Banbury. Its trains on the London extension were noted for comfort as well as for speed, but the question of locomotive and rolling stock design must be reserved for later chapters.

Table V, p. 147, is sufficient to give a general impression of the growth of the Great Central Railway over a period of sixty years.

The Great Eastern Railway

The third large Company which, in conjunction with the late Great Northern and Great Central Railways, now forms the Southern Area of the L.N.E.R., was the Great Eastern Railway, famous among railway officers throughout the world for the efficient handling of suburban traffic.

As was seen in an earlier chapter, the Eastern Counties Railway, built originally to 5-foot gauge, had been constructed in the late thirties from the eastern side of London to Colchester, to which the line was opened on March 29th, 1843. Connection was made to Ipswich by means of the Eastern Union Railway. The Great Eastern could also make a further claim to ancient railway lineage, since a portion of its system was the London and Blackwall, authorized by an Act of 1836 and opened in 1840. Robert Stephenson was the engineer for the line, and it used Fenchurch Street Station,[1] the London terminus of many of the Eastern Counties' suburban trains in early days, although at its opening the western terminus of the London and Blackwall line was at Minories.

[1] From 1858 this station has been the terminus of the London, Tilbury, and Southend trains and served the same purpose for a certain period for the North London trains also, prior to the opening of Broad Street Station in 1865, though North London trains used Fenchurch Street until December, 1869.

Originally worked by ropes, this interesting little line was first constructed to the 5-foot gauge, like its larger neighbour, the Eastern Counties, Rennie being responsible for the choice of this unusual gauge measurement, in the former case, and Braithwaite in the latter. Locomotives were brought into use prior to 1850, owing to the unsatisfactory working of the rope system, the standard gauge being adopted in the same year. The Great Eastern obtained a lease of the London and Blackwall in 1866 and thereby acquired a City terminus before Liverpool Street Station was built in 1874, which to-day gives it an alternative station for local traffic, though Fenchurch Street Station was largely used by the London, Tilbury, and Southend, whose headquarters it was prior to the latter's absorption by the Midland Railway.

On January 1st, 1844, the Eastern Counties took over by lease [1] a neighbouring line, the Northern and Eastern, familiar to present-day readers as the Cambridge line of the Great Eastern section, also built to the 5-foot gauge. In 1845 Hudson took over the chairmanship, and it is reported that the prospects brightened. The Eastern Union Railway was planned as a line from Colchester to Ipswich with a short branch to Hadleigh, and its Bill received the Royal Assent in June, 1844. The line was opened to Ipswich in June, 1846, while the Ipswich and Bury, incorporated by an Act of 1845, was leased from January, 1847. This line was 27 miles long and had been opened at the end of 1846. The Eastern Union's 31-mile extension from Haughley on the Ipswich and Bury, to Norwich (Victoria), was opened before the end of 1849, thus completing railway communication between Norwich and London. A connection was made at Norwich (Trowse) with the Norfolk Railway in 1852, thus permitting trains from London to use the Thorpe station at Norwich.

Like all the British railways, the Great Eastern resulted from the combination of many small lines; thus, the

[1] The terms of this lease were a perpetual guarantee of 5 per cent. dividend on paid-up capital. This lease was terminated in 1902 by an Act of Parliament which amalgamated the Great Eastern and the Northern and Eastern.

Norwich and Brandon, authorized in 1844, which had been estimated to cost £10,000 per mile by Robert Stephenson and Mr. Bidder, the engineer, combined with the Norwich and Yarmouth, opened in 1844, to form the Norfolk Railway, which in its turn absorbed the Lowestoft line. The Norfolk Railway connected with the Eastern Counties at Trowse near Norwich, and finally came under the management of that railway, which together with the Northern and Eastern had been converted to the standard 4ft. 8½in. gauge late in 1844. By the end of July, 1845, Yarmouth was in rail connection with London by way of Norwich. In 1847 Lowestoft was reached from Norwich.

The Great Eastern did not adopt this title until 1862, eight years after the Eastern Counties had amalgamated with the Ipswich and Bury, and leased the Colchester, Stour Valley, Sudbury, and Halstead. This small Company owned a branch from Marks Tey on the Eastern Counties to Sudbury in the north, and another from Colchester to Hythe, which were authorized in 1846; the line was leased to the Eastern Union in 1847. The Eastern Union itself was worked by the Eastern Counties from the beginning of 1854. The Great Eastern was actually the result of the amalgamation of the Eastern Union, the Eastern Counties, the East Anglian, the East Suffolk, and the Norfolk Railways. The East Anglian, a line which itself was the amalgamation of three small lines, was authorized by Act of 1845. These were the Ely and Huntingdon, from St. Ives to Huntingdon, opened in 1847, the Lynn and Ely opened in 1847, and the Lynn and Dereham opened throughout in 1849; all of which had been worked by the Eastern Counties system since 1852. At a later date the East Suffolk running from Woodbridge to Yarmouth, opened in 1859, the Fakenham and Wells, and the Newmarket Railways were also absorbed. During the seventies and eighties many small additions were made to the Great Eastern system, such as the absorption of the Thetford and Watton in 1879 and the construction of the Southend line in 1888–1889. As a result of these numerous amalgamations the

Great Eastern consisted of an eastern main line running through Romford, Chelmsford, and Colchester to Ipswich, where it divided into two lines ; the more easterly running near to the coast terminated at Great Yarmouth, with an important branch from Beccles to Lowestoft. The more westerly line, after throwing off a branch westwards to Bury, Newmarket, and Cambridge, ended in a terminal station at Norwich (Thorpe),[1] where trains reversed to proceed further north to the coast resorts of Cromer, Sheringham, and Mundesley, or by the connecting lines to Yarmouth and Lowestoft.

The other main line of the Great Eastern ran almost due north through Bishop's Stortford to Cambridge, where connection was made with the London and North Western, Midland, and Great Northern Railways. From Cambridge the line passed through Ely, where it divided into three : one line diverged to the east, joining up with the Ipswich main line at Norwich ; the second continued due north to King's Lynn and Hunstanton, the popular summer resort ; while the third and most important ran north-west to March, whence there was an important branch to Peterborough. From March it continued jointly with the Great Northern through Lincoln and Gainsborough to a point near Doncaster, where traffic was transferred to and from the Great Northern Railway. This long northward main line was of considerable importance to the Great Eastern, as it was thereby enabled to tap the important south-bound coal traffic and at Doncaster to get into touch, not only with the Great Northern, but also with the Great Central and the Lancashire and Yorkshire Railways. In spite, however, of this important coal traffic and connecting link with industrial Yorkshire, the Great Eastern, so far as its freight traffic was concerned, was mainly miscellaneous in character, and it was unfortunate for the old Great Eastern shareholder that the terms of exchange of shares into those of the new L.N.E.R. Company had to be arranged before the full force of the present trade de-

[1] Passenger trains used to run into Norwich (Victoria), now only used for goods traffic.

pression had made itself felt. With prosperity dependent on so many interests, varying from the new sugar-beet industry and the famous Yarmouth bloater to Cambridgeshire fruit, and Danish butter and bacon, trade depression cannot affect the line as seriously as those serving such areas of heavy industrial development as South Wales, the Tyneside, or the Clyde district. That this is so is shown by the circumstance that increased facilities for handling the freight traffic on this Great Eastern section of the present L.N.E.R. have become essential and are being pushed ahead with expedition.

Mainly running through agricultural areas, the Great Eastern developed its services from Parkeston Quay near Harwich to the Continent, chiefly the Hook of Holland, and Antwerp, with great efficiency, and just prior to amalgamation entered into agreements for the running of a train-ferry service from Harwich to Zeebrugge. These train-ferry steamers proved their value during the war in transporting stores and rolling stock from Southampton to Dieppe, and from Richborough to Dunkirk and Calais, and there can be little doubt that once the insular prejudices have been broken down, the train-ferry service should prove a first-rate financial asset to both the Belgian State Railways and to the L.N.E.R.

The Great Eastern, however, was most famed for its handling of suburban traffic. Its London terminus at Liverpool Street, which cost more than £2,000,000, was opened for full traffic in 1875, and is well within the city, being only a few minutes' walk from the Bank, which has legitimately been termed the financial centre of the British Empire. Any large terminus with such advantages was bound to attract a large suburban traffic, but in order to get through Parliament the Act permitting the building of this large station so near the centre of London, the railway had to promise cheap fares from such stations as Edmonton and Walthamstow to the population so displaced. Hence suburban season ticket rates from Liverpool Street have been extremely cheap, and this has helped to build up the enormous traffic which has had to be dealt with in recent years. In 1924 Liverpool Street

was dealing with nearly a quarter of a million passengers each week-day.

This type of traffic operation, entailing peak loads in the so-called crush hours, is a specialized problem, experienced only in large cities such as London, New York, Liverpool, and Chicago, and considerable attention will be paid to both the theoretical considerations which underlie its solution, and the practical considerations by which it is solved, when we come to discuss the problem of passenger train services.

Liverpool Street Station at present contains eighteen platforms and twenty roads, which are reached by six tracks from Bethnal Green down a steep gradient, for 32 chains as steep as 1 in 71, which requires good locomotive work on heavy down trains since it is not the custom to use bank engines on departure. On the Ipswich main line a long bank has to be ascended until Brentwood summit is reached, made more difficult in wet autumn weather by slippery rails. This Brentwood bank, which is met with by both up and down trains, tends to limit the loading of fast passenger trains, such as the Norfolk, Yarmouth, Clacton, Southend, and Boat expresses to Harwich.

Table V, p. 147, is sufficient to give a general impression of the growth of the Great Eastern Railway over a period of sixty years.

The North British Railway

The main constituent Company north of the Border which became part of the L.N.E.R. system as a result of the Railways Act of 1921 was the North British Railway. It traces its ancestry back to the Monkland and Kirkintilloch Railway mentioned in Chapter II, but two other small railways, also previously mentioned, became included in the erstwhile North British Company's lines, namely the Ballochney Railway, closely associated with the Monkland and Kirkintilloch, and the Edinburgh and Dalkeith. None of these lines became the property of the North British until after 1840, for the North British Railway itself, which ran from Berwick to Edinburgh,

was not opened until 1846, although incorporated in 1844. It took over the Edinburgh and Dalkeith in 1845, but it was not until the sixties that the North British took the form which is familiar to twentieth-century railwaymen, for in 1862 it amalgamated with the Edinburgh, Perth, and Dundee, which had in its turn absorbed the Edinburgh and Northern. Similarly this latter had, some years earlier, taken over the Edinburgh, Leith, and Granton, a line incorporated in 1836 under the name of the Edinburgh, Leith, and Newhaven. Three years later, in 1865, the North British took over the Edinburgh and Glasgow Railway, opened in 1842, part of which had been the Monkland and Kirkintilloch and Ballochney lines. This series of amalgamations ushered in a period of general railway construction, consisting mainly of comparatively short lines which were primarily built for feeding purposes or to assist local industrial developments.

To the south of Edinburgh was an important section of the North British Railway, to-day known as the Waverley route, which has been developed from an original stem from Edinburgh to Hawick, authorized in 1845. Opened in 1849, powers were obtained during the fifties for its extension to Carlisle, where connection could be made with several English Companies, as well as with the Scottish Caledonian, and the Glasgow and South Western. This route passing through Carlisle terminated at Silloth and possessed very heavy gradients. It was open to traffic by 1862, and in time this line was connected to the North Eastern Railway at Morpeth and Hexham. North of the Forth, North British interests were rapidly monopolizing the development of the valued Fife coal-fields. The port of Burntisland, now famous for its coal shipment, at that time was famous as being the northern end of the ferry service from Granton, the main route until the opening of the Forth Bridge in 1890.

In the Glasgow area the acquisition of the Edinburgh and Glasgow carried with it the Edinburgh and Glasgow Union Canal, whilst the opening of the Glasgow and Coatbridge line in 1870 still further strengthened the North British position in that area; the very early

Dundee and Arbroath of 1836 came into joint North British and Caledonian possession on February 1st, 1880. Northwards to Aberdeen the North British ran over the Scottish North Eastern which in 1865 became part of the Caledonian. The main developments during the next twenty years were the taking over and construction of new lines in the suburban areas of Edinburgh and Glasgow ; the development of docks, and the opening of the East Fife Central line in 1898. The most recent extension of any great importance to the North British Railway has been the West Highland line, 140 miles long, opened to Fort William in 1894. This West Highland line was leased to the North British Railway, which guaranteed 3 per cent. on its authorized capital. The North British line connecting with the West Highland follows the north bank of the Clyde, which enabled it to share in the lucrative Clyde steamer traffic, and after serving these steamer routes at Craigendoran turns north and becomes the West Highland. A single track, heavily graded, skirts Loch Lomond, crosses Rannoch Moor, at a height of 1,350 feet, and reaches tidewater at Fort William in Inverness-shire, from which it is continued on to Mallaig on the Atlantic Coast, reached in 1901. North of Loch Lomond this line, from which can be seen some of the finest scenery in Great Britain, could never have been a success financially, for its maintenance is heavy, and the population per mile very small, but it has opened out commercially a large area of Western Scotland, and may, in time, as a result of afforestation policy prove its financial soundness. The British Aluminium Company are already developing the power resources of Loch Laggan and Loch Treig.

The eastern side of Scotland is indented by wide arms of the North Sea, such as the Firth of Forth and the Firth of Tay, therefore, if Edinburgh was to be connected by rail with Dundee and Aberdeen, it was inevitable that early attempts would be made to bridge these inlets of the sea. The more northerly of the two was attempted first, and in July, 1878, the first Tay Bridge, 3,465 yards long, which had no less than eighty-five spans, was opened

for railway traffic. On December 28th of the following year it proved to be the scene of a terrible accident, for it collapsed in the teeth of a heavy gale, carrying a train with it, seventy-two passengers being lost. Such a disaster naturally delayed for several years the construction of a bridge across the Firth of Forth, but in 1882 an Act to build such a bridge by the Forth Bridge Company was passed, and various English lines, including the Midland, helped the North British to guarantee the expense of the structure. This enormous engineering feat was completed and opened by the Prince of Wales in 1890, three years after the second Tay Bridge had been opened for traffic.

The completion of the Forth Bridge was in reality the cause of the famous races to Aberdeen in 1895, for prior to the opening of the bridge the West Coast route had been the normal one for travellers from the south to Aberdeen and beyond. The North British and the East Coast route partners were not in a position to compete, as the Caledonian naturally gave preference to its own trains. After the bridge was opened for traffic the East Coast route was in a much stronger position to compete and quickened their services from London. This challenge was taken up by the West Coast partners and there resulted the races to Aberdeen in 1895.

The North British was justly proud of its Edinburgh (Waverley) Station. Built for through running, with dead end bays for terminal traffic, this station is one of the largest in Great Britain, containing nine platforms and a total length of platform faces of 13,980 feet, and it covers no less than 18 acres. At Glasgow trains were assisted out of Queen Street Station until 1908 by means of a steel rope up a gradient of 1 in 45 to Cowlairs.

Like so many other British railways whose financial welfare was largely dependent on coal, the North British assisted this traffic by efficient port management at Bo'ness, Methil, Alloa, and Burntisland on the east coast, whilst the Company on the west coast was represented by the port of Silloth. The total area of these docks amounted to over 76 acres.

TABLE V.—Growth of the Chief Constituent Companies

	Great Northern Railway.		
	1865.	1900.	1922.
Total passengers carried (exclusive of season ticket holders)	6,763,470	37,671,162	31,195,809
Season ticket holders, all classes	3,857	159,900	58,970
Length of line open (route mileage)	440	825	945
Ratio of working expenses to gross receipts (operating ratio)	51%	65%	80%
Minerals carried (tons)	2,254,218	9,452,467	17,223,972
General merchandise carried (tons)	1,990,237	8,095,999	5,034,001
Average fare per mile (pence):			
(*a*) First class	2·13	[1]	[1]
(*b*) Parliamentary or third class	1·00	[1]	[1]
Paid up capital (£) (shares and debenture loans)	16,041,901	56,061,281 [3]	64,334,801 [4]
Average rate per cent. of dividend on ordinary capital	7⅛ [4]	4 [4]	4 [5] & 7 (pref.) (def.)
Compensation for personal injury (£)	22,387 [6]	12,282	3,377 & 21,131 (passengers) (workmen)
Rates and taxes	31,303	188,580	427,404 & 8 (rates) (taxes)
Compensation for damage and loss of goods (£)	—	39,690	35,042
Total working expenses	986,665	3,446,356	10,028,669

* For qualifying remarks see page 48. [1] Not available. [2] See page 50. shares. [6] Includes compensation for damage and loss of goods.

Table V, p. 149, is sufficient to give a general impression of the growth of the North British Railway over a period of sixty years.

The Great North of Scotland Railway

The other constituent Company to form the present L.N.E.R. was the Great North of Scotland Railway incorporated in 1846, a short line connecting Aberdeen to Elgin, with branches to Peterhead, Fraserburgh, Macduff,

OF THE LONDON AND NORTH EASTERN RAILWAY.*

MANCHESTER, SHEFFIELD AND LINCOLNSHIRE (GREAT CENTRAL RAILWAY).			GREAT EASTERN RAILWAY.		
1865.	1900.	1922.	1865.	1900.	1922.
4,982,232	18,443,272	23,663,271	12,878,345	116,103,401	86,681,531
864	263,802	23,932	3,166	42,719	91,015
246	494	720	756	1,110	1,176
46%	70%	82%	58%	62%	87%
2,146,514	13,615,375	27,707,442	885,400	4,083,622	7,151,088
1,492,462	7,164,420	5,143,328	1,632,534	7,558,764	5,083,584
2·43	[1]	[2]	2·35	[1]	[2]
0·97	[1]	[2]	0·97	[1]	[2]
10,521,843	42,060,782	61,795,178 [4]	24,219,305	50,765,742 [3]	55,376,117 [4]
2·25	Nil	Nil	Nil	3	2¾
6,483	11,390	68 & 13,579 (passengers) (workmen)	21,996	4,446	7,553 & 23,868 (passengers) (workmen)
11,700	103,516	235,813 & 71 (rates) (taxes)	35,053	248,381	562,429 & = (rates) (taxes)
1,118	20,306	23,993	9,152	30,940	25,509
396,952	2,332,650	8,915,280	980,913	3,490,252	9,671,798

[3] Including nominal additions. [4] Created. [5] On major portion of ordinary

Banff, and Boat of Garten, while a southern branch of the line followed the valley of the Dee from Aberdeen to Ballater. The greater part of this railway's mileage was single track, and was constructed during the fifties. Like all British lines, the Great North of Scotland was the amalgamation of numerous local lines. Besides a large livestock traffic, the line was noteworthy for the amount of fish traffic which originates at its North Sea ports, and which it handed over to its more southerly neighbours

TABLE V.—Growth of the Chief Constituent Companies of

	North Eastern Railway.		
	1865.	1900.	1922.
Total passengers carried (exclusive of season ticket holders)	12,977,135	57,573,747	58,333,350
Season ticket holders, all classes	3,502	22,261	45,565
Length of line open (route mileage)	1,205	1,654	1,847
Ratio of working expenses to gross receipts (operating ratio)	47%	63%	83½%
Minerals carried (tons)	15,309,991	41,251,796	50,569,529
General merchandise carried (tons)	4,305,661	11,875,117	9,927,147
Average fare per mile (pence): (*a*) First class	2·10	[1]	[2]
(*b*) Parliamentary or third class	0·85	[1]	[2]
Paid up capital (£) (shares and debenture loans)	35,497,406	73,057,671[3]	91,011,310 [4]
Average rate of dividend on ordinary capital (per cent.)	6·0 [5]	6⅜	7½
Compensation for personal injury (£)	14,355 [6]	12,057	4,233 & 46,160 (passengers) (workmen)
Rates and taxes	60,495	342,610	760,090 & 113 (rates) (taxes)
Compensation for damage and loss of goods (£)	—	23,749	40,120
Total working expenses	1,674,405	5,824,622	16,390,717

* For qualifying remarks see page 48. [1] Not available. [2] See page 50. ordinary shares. [6] Includes compensation for damage and loss of goods.

at Aberdeen. In summer its territory attracted a large tourist traffic, while its line formed the direct connection from Aberdeen to Inverness, the centre of the Highlands, to which city it ran over the tracks of the late Highland Railway, now the northernmost part of the L.M.S.R.

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THE LONDON AND NORTH EASTERN RAILWAY * (*cont.*).

NORTH BRITISH RAILWAY.		
1865.	1900.	1922.
7,876,817	39,160,225	32,051,156
5,650	39,707	39,560
723	1,242	1,293
43%	54%	78%
4,175,110	18,382,418	22,803,953
1,545,158	4,646,734	5,011,426
1·96	[1]	[2]
0·92	[1]	[2]
17,690,200	57,281,943 [3]	70,625,085 [4]
3·0 [3]	⅜ & 3	3 & 1 (pref.) (def.)
4,621	7,108	2,795 & 12,708 (passengers) (workmen)
20,424	99,372	204,077 & 20 (rates) (taxes)
4,544	14,392	20,870
559,413	2,322,068	7,540,610

[3] Including nominal additions. [4] Created. [5] On major portion of

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CHAPTER VII

DEVELOPMENT OF THE PERMANENT WAY

The collective term, permanent way, or the "track," consists of four main constituent parts: the rails, the sleepers upon which the rails rest directly or indirectly, the fastenings, and the foundations of which the top layer is commonly known as ballast. Although combined in function, these individual parts as regards their development in railway history can preferably be considered separately. It is the need for a specially designed track which distinguishes rail transport from its sister methods of water, road, and air transport.

It would be outside the province of this book to trace up the varying devices used from classical and mediaeval times to reduce the friction of the wheel, since rail transport in its usually accepted meaning refers only to that type of transport where flanged wheels are used and the motive power is other than that of human beings or horses. William Jessop has been credited with the transfer of the flange from the rail to the wheel as early as 1788. In earlier railway histories the term "railroad" is used rather than "railway," and the former is still used to a large, though perhaps diminishing, extent in the United States.

The earliest conceptions of rail transport appear to have had in view merely the laying of timber planks on ordinary roads, so that the friction of the wheels might be reduced and a greater load hauled by the horse. As these planks rapidly wore out they came to be topped with metal strips, which were so narrow that they cut into the wheel tyres. Metal alone was used for this work at later dates. As early as the later half of the eighteenth century the Coalbrookdale Ironworks are known to have

cast some plate rails, namely, rails of an L design of cross-section some 3 feet long. The rails were placed thus, ⌋ L, the upright section serving to guide the wheels. Rails of this pattern could be seen only a few years ago on the Ticknall Tramway acquired by the Midland Railway in 1846 and built for the carriage of lime from Ticknall to the Ashby Canal. In the Science Museum at South Kensington may be seen an old plate rail point made of cast iron, and used on this Leicestershire tramway by Benjamin Outram in 1799. The recently discovered rails of the Silkstone Railway of 1809 are of the groove type and are made of cast iron.

At a later date it became customary to fit the plate rail with a perpendicular flange which, engaging in the ground, served to keep the rail in position; the general form of this improved design may be likened to a T resting on its side.

As long as horses were the form of motive power in use there was little need for a track separate from that of the road. Though many of our earliest examples of horse-hauled railways were utilized only for coal or stone movement, the mode of transport was not unlike that of the horse tramway system of comparatively recent days.[1] A difficulty largely over-estimated by Trevithick, Blenkinsop, and other early engineers was the supposed lack of adhesion which would result from the contact of a smooth-surfaced iron rail with smooth-surfaced iron locomotive wheels. Hence, one finds that Blenkinsop, in 1811, took out a patent for a racked, or tooth, rail laid along one side of the road, into which the toothed wheel of his locomotive worked, as pinions work into a rack. The boiler of his engine was supported by a carriage with four wheels without teeth, and rested immediately upon the axles.[2] Mr. Blenkinsop's engines as thus described apparently ran with success from the Middleton Collieries to Leeds in 1812, with trains of thirty 4-ton chaldron type coal wagons, at a speed of

[1] Oxford still used horse trams in 1913.

[2] *Story of the Life of George Stephenson*, by Samuel Smiles.

nearly 4 miles per hour.[1] "Mr. Blenkinsop's Patent Steam Carriage and Rail-way used 40 lb. per yard plain Rails on a pedestal of iron weighing 6 lb., a cogged rail of 56 lb. per yard with a pedestal of 14 lb. These rails cost 12*s.* per 100 lb." [2]

Two main types of rails existed, to some extent as rivals, in the early days of British railways, namely, the plate or L-shaped rail already described, and the edge rail much like the bull-headed rails of to-day, in that it carried the wheel on its top edge. Cast-iron edge rails were used in 1811 on the Kilmarnock and Troon, a Scottish mineral line. In general, the edge rails were more popular in the north of England, and the plate rails in the south, where the Surrey Iron Railway had adopted them during the first years of the nineteenth century. All these early rails appear to have been constructed of cast iron, each rail not greatly exceeding 3 feet; the jointing between adjacent rails was made by the top part of one resting upon the projecting lower part of the next. This "half-lap joint," [3] was designed by George Stephenson, who gave up the bolt joint of ordinary perpendicular section in order that the locomotive he was then designing might not be exposed to derailment every 3 feet or so. This type of rail appears to have been first put into use on the Killingworth Colliery Railway, there replacing old cast-iron plates. The Stratford and Moreton Tramway, opened in 1826 and at first using horse traction, employed a fish-bellied type of iron rail, 15 feet in length.

The story of the choice of rail to be adopted for the Stockton and Darlington Railway is one of the most interesting in early railway history. Samuel Smiles, in his *Life of George Stephenson*, says that "originally the directors had contemplated laying down a wooden tramroad, but Stephenson, advising an iron road, was interviewed by the directors." He was himself interested in

[1] *Story of the Life of George Stephenson*, by Samuel Smiles.

[2] *Observations on a General Iron Rail-way or Land Steam-Conveyance*, by Thomas Gray.

[3] *Story of the Life of George Stephenson*, by Samuel Smiles.

the patent for cast-iron rails, which he had taken out with Mr. Losh in 1816; and, of course, it was to his interest that his products should be adopted. But when requested to give his opinion on the subject, he frankly said to his directors: "Well, gentlemen, to tell you the truth, although it would put £500 in my pocket to specify my own patent rails, I cannot do so after the experience I have had. If you take my advice, you will not lay down a single cast-iron rail." "Why?" asked the directors. "Because they will not stand the weight; there is no wear in them, and you will be at no end of expense for repairs and re-lays." "What kind of road, then," he was asked, "would you recommend?" "Malleable rails, certainly," he said. Owing to the fact that malleable rails cost rather more than twice as much as cast-iron rails, 800 tons of each were ordered.[1] Thus, the Stockton and Darlington line, opened for traffic on September 27th, 1825, adopted a malleable iron rail for half of its mileage. Both this and the Canterbury and Whitstable Railway employed rails weighing 28 lb. per yard.

By the thirties wrought-iron rails had become more popular than the older type made of cast iron, and the edge rail had conquered with ease its earlier rival, the plate rail, although in a few cases the edge and tram types of rail were combined in one. Amongst notable cases of this were the rails used on the Rumney Tram-road about 1835. The length of rail had also increased and rails of 18 feet were not unknown during the earlier years of this decade. Nearly all the early rails were "fish-bellied" in form, namely of a deeper vertical section in the middle than at the ends; the supports were customarily placed at intervals of a yard. The Liverpool and Manchester Railway adopted a rather heavier rail of the same fish-bellied type as the Stockton and Darlington, but weighing 35 lb. to the yard and 12 or 15 feet long. Only seven years after its opening

[1] "The malleable rails cost £12 per ton and were 28 lb. to the yard, 2½ in. thick, with the upper flange ¾ in. thick; the cast iron £5 10*s.* per ton."—*Story of the Life of George Stephenson*, by Samuel Smiles.

in September, 1830, these rails had to be replaced by those of a heavier type. Four years later the fish-bellied type of rail, owing to difficulty of manufacture, was abandoned and replaced by rails of uniform section weighing 50 lb. per yard. The Leeds and Selby Railway, opened in September, 1834, adopted a T-shaped rail weighing 35 lb. to the yard with a length of 15 feet.

Since the pioneer railways in this country adopted a solid type of rail either of cast or malleable iron, it is not surprising, perhaps, that the wooden rail with straps of iron was never prominent in early permanent way design, but in the United States it was used on many of the early lines. Thus, "On the South Carolina Railroad the timber rails had a cross section measuring 6 by 12 inches, and the strap iron was $2\frac{1}{2}$ inches thick." [1] In 1830, the Camden and Amboy Railway, in the United States, put into service a flat-bottomed rail to the design of R. L. Stevens (1787–1856). By means of the flat base, chairs were dispensed with and the rails fastened direct to the sleepers by metal spikes. This type of rail, often known as the Vignoles rail, after the early railway engineer, C. B. Vignoles (1793–1875), is now more commonly called the flat-bottomed rail, and is in almost universal employment outside Great Britain. Among early British lines favouring this type of rail were the old Eastern and Midlands Railway.

Besides the flat-bottomed rail, two other designs of rail came into use during the thirties. The Grand Junction Railway, opened in 1837, used a rail of which both the upper and lower sections were exactly similar, the main advantage being that it was deemed possible to reverse the rail after the top had been worn. In practice, however, it was found that the hammer action of the bottom of the rail against the chair caused indentations which did not conduce to smooth running when the rails were reversed. Joseph Locke has been credited with the design of this double-headed rail, as it was called, and it is important, because the present type of

[1] *Principles of Railroad Transportation*, by Johnson and Van Metre.

rail, known as "bull-headed" design, is evolved from it. The bull-headed rail is very similar, but the upper section, which comes in contact with the wheels, is of considerably greater cross-section and consequently heavier than the lower part which rests in the chairs.

In 1842 the Manchester and Birmingham was using 65 lb. per yard, 15-foot rails, which were kept in position by cast-iron pedestals. The Manchester and Leeds, a 4ft. 9in. gauge line, also employed 15-foot rails in 1840; its earlier neighbour, the Manchester, Bolton, and Bury of 1838, used rails weighing 55 lb. per yard. The Sheffield and Rotherham Railway in 1838 used lighter rails of 52 lb. to the yard.

Isambard Brunel used on his broad gauge, on the Great Western, a rail of inverted U formation, known as the bridge-rail, which was fixed to longitudinal wood sleepers by bolts which passed through the horizontal sections of the rail on either side of the inverted U formation. It was not until 1892, when the broad gauge was abandoned, that this rail gave place to the bull-headed type on the Great Western Railway.

By the year 1848, a rail weighing 54 lb. to the yard, of the wrought-iron, single-headed type, was in use on the Leeds and Thirsk Railway, though some years earlier a 62-lb. wrought-iron double-headed type of rail had been put into service on the Hull and Scarborough Railway, whilst by 1845 its neighbour, the York and Scarborough, was using a 75-lb. wrought-iron single-headed rail. In 1851, the London and North Western Railway, which the year before had adopted the bull-headed design, was using a rail weighing 75 lb. per yard, and thirty-six years later a rail of 90 lb. per yard. By 1862, the standard double-headed rail for the North Eastern Railway weighed 82 lb. to the yard, but the single-headed type of steel rail weighing 90 lb. to the yard was favoured by the same railway in 1890. The latter was in use until 1910, when the British Standard Section Steel Rail, weighing 95 lb., was adopted.

The period from 1860 to 1880 is a very important one to those interested in the history of the rail, for about

1870 Henry Bessemer invented his process of steel manufacture, and the open-hearth process, which was soon to follow, resulted in the use of the harder type of rail and, incidentally, harder wheel tyres. The steel rail largely eliminated the trouble, which had been experienced from the early railway days, of the wear of the rail, caused by action of the flanges. The introduction of steel permitted much heavier axle loads, thus achieving increased adhesion, and trains nearly three times as heavy became a practical possibility.

Concurrently with the increase in weight per yard, the length of rail showed a steady increase, though the practice of individual railways varied considerably as regards this question. For many years, the 30-foot rail was a standard on several lines, and later on, a 36-foot was in certain cases substituted for it. Other lines favouring a long rail with a consequent proportional reduction in the number of joints, introduced 40-foot, 45-foot, and even 60-foot rails. Railway companies in this country may be said to favour a longer type of rail than most foreign railway administrations, and it is noteworthy that the London and North Western, which largely manufactured their own rails at Crewe works, adopted a 60-foot rail as early as 1894 for its main line. Undoubtedly, the comparatively temperate climate of this country was in favour of the longer rail, as less space had to be left for expansion in hot weather. Since 1920, many United States lines have begun buying rails longer than 30 or 35 feet, but the considerably greater manufacturing cost has militated against their general use.

In 1915, of six leading British railways, four used a 45-foot rail, the London and North Western used a 60-foot rail, whilst the Great Western standardized on the 44½-foot type. As illustrating the approximate position of several railways in 1918, one may take as examples the current lengths of rails in use on the railways forming the East Coast route at that date. The Great Northern main line was composed mainly of 36- and 45-foot rails with certain lengths of 30-foot; the North Eastern rails were 45 and 30 feet; the North British 24, 40, and 45

feet in length ; while the Great North of Scotland standard rail was 30 feet. The Midland and London and North Western Railways, in certain places, had the heaviest standard rail, weighing 100 lb. to the yard ; the Great Western Railway favoured a 97½-lb. rail ; the London, Brighton, and South Coast, a 96-lb. rail ; the North Eastern and Great Eastern, 95 lb. ; and the London and South Western a 90-lb. rail.[1] In 1924 the British Standard Section Steel Rail weighed 95 lb. per yard ; the 45-foot length was employed except on the London, Midland, and Scottish where 60-foot rails are largely used. For branch lines the standard rail is one weighing 85 lb. per yard. In the United States, some railways, notably the Lehigh Valley, which has a standard 136-lb. rail, have adopted a much heavier rail than the present standard for this country, but it should be remembered that the railways on the North American continent do not benefit by the chair system of support.

The minimum length of rail permitted by the Ministry of Transport is, as a rule, 30 feet, except where the line is normally used for light traffic at moderate speeds. For lines where the normal traffic is heavy and worked at high speed, the minimum weight of rail permitted is 85 lb. per yard.[2]

In Great Britain rail joints are squared, that is, the joints in the right- and left-hand rails are placed exactly opposite one another ; in Canada and the United States the normal practice is to stagger the joints, that is, the joint on the left-hand rail is opposite the centre of a right-hand rail. Nearer home, the late Great Southern and Western Railway of Ireland standardized on staggered joints ; although many British lines have often laid down test lengths, the system cannot be said to have met with favour in Great Britain.

Even in the early days of the Stockton and Darlington and the Liverpool and Manchester Railways, it was found necessary to have some metal support which would

[1] *Permanent Way*, by W. H. Cole.

[2] Requirements for passenger lines and recommendations for goods lines of Ministry of Transport, 1925.

hold the rail in an upright position. Thus, in 1825, cast-iron chairs were in use on the Stockton and Darlington Railway; whilst at Liverpool may still be seen part of a chair used on the Liverpool and Manchester. These early chairs weighed 15 lb. to 17 lb. each, and were fastened to the sleepers by two iron spikes. Cast-iron chairs, 3 feet apart, were also used in 1834, to support the wrought-iron rails of the Leeds and Selby Railway, while the 80-lb. rail of the York and North Midland was held in position on the longitudinal beams used on this line, by cast-iron chairs. In the following year, rails designed by Mr. Losh, a friend of George Stephenson, were used on the Hexham and Blaydon Railway; constructed of wrought iron, they were secured to the cast-iron chairs by wrought-iron keys. The North Midland and the Manchester and Leeds Railways in the early forties used chairs; the rails were held in position by a tapering key of wrought iron, 8 inches long, and a ball rather over half an inch in diameter which fitted into grooves on each side of the rail. The Manchester, Bolton, and Bury in the late thirties used cast-iron pedestals.

In view of these numerous examples of cast-iron chairs in use on early British railways, it is surprising that the chair has not been used to a greater extent outside Great Britain. In Canada and America, a flat-bottomed rail has been standard for many years, and even before its adoption, it had been customary to spike the older ⊓ type of rail direct to the sleeper or cross-tie, and the expense of the chair was thereby dispensed with; an important development in new countries where first cost is a very vital consideration. The chairless rail has become standard for the greater part of the railway mileage of the world, but the smoothness of travel on the railways of Great Britain is often largely attributed to the chair system of construction of its permanent way, though possibly this is mainly due to better ballasting and more careful maintenance.

The design of chair has changed considerably in the course of its development, but the majority of the early designs provided for a single spike on either side of the

rail, and this type appears to be almost universal until 1850; by 1855, however, the London and North Western Railway had in use chairs pierced with two holes on the inside, and one on the outside. In this case, double-headed rails were held in position by wooden keys. Many of the early rail joints were supported by chairs, known as joint-chairs, but the hammer action of the wheels tended to loosen the fastenings at these joints. To overcome this difficulty the suspended joint was invented in which the rail-ends were held together by fish-plates with no supporting joint-chair. The invention of the fish-plate is attributed to Stevens, who apparently first used it in connection with flat-bottomed rails on the Camden and Amboy Railroad. These metal fishes, as they were originally called, were first of all wedged in, but subsequently they were bolted to the two rails. In England they were first used on the Eastern Counties Railway about 1847, in a form closely allied to that of the present-day fish-plate. The suspended joint with fish-plates appears to have been common on British railways by the fifties, and the system remains the same with minor alterations to the present day. Fish-plates, originally made of wrought iron, are now almost invariably made of steel, being held in position by four pear-necked fish-bolts. The British standard fish-plate of to-day is 18 inches long.

Like the rails, the weight of the chairs has shown continual increase, though efforts have recently been made to reduce the weight without decreasing the strength of the chair. A 54-lb. cast-iron chair secured with two wrought-iron spikes and two solid oak trenails was the standard practice on the Midland Railway in the early years of this century, whilst the London and North Western Railway used chairs of a similar weight at the joints and lighter ones weighing only 45 lb. at intermediate positions.[1] This latter line secured their chairs by two steel screws driven through oak ferrules and two steel spikes, a felt pad being interposed between the chair and the sleeper. The latest standard British specification

[1] *Permanent Way*, by W. H. Cole.

provides for chairs weighing 46 lb. with two galvanized coach screws driven through oak ferrules on the inner side of the rail and one of similar pattern on the outer side. It is of interest to note that the minimum chair specifications laid down by the Ministry of Transport are lower than the specifications adopted by the four present Companies, since the requirements only call for 45-lb. chairs on lines used for heavy and fast traffic, and in cases where traffic conditions are less severe the minimum weight of chairs permitted is only 40 lb.

In Great Britain, unlike the American practice with the flat-bottomed rail, the rail is actually held at a cant of 1 in 20 by the shape of the chair and fixed by the keys, which are, in modern practice, usually wooden, oak being one of the most favoured woods for this purpose. Metal keys have been tried at various times and on numerous railways, including the Liverpool and Manchester, which, at its opening, used iron wedges, but in Great Britain they have never met with the success which they have achieved abroad in the relatively few cases in which chairs are employed. The keys vary somewhat in length and design, but are normally about 6 or 7 inches in length, and in some cases they are wedged slightly; in others they remain rectangular.

The chairs which support the rails are, in their turn, secured to sleepers or cross-ties, which hold them true to gauge, which in Great Britain is 4ft. $8\frac{1}{2}$in., thus following out the space between the wheels on the old horse carts which in their turn had fixed the gauge of stone and plate ways. This seemingly odd choice of distance appears to have arisen from Jessop's transference of the flange from the rail to the wheel. His wheel-flange ran inside the rail top. This shifted the governing measurement for the cross-distance between the wheels from an overall rail separation of 5 feet to that of 5 feet less the combined width of the two rail tops.

On many of the early tramways, the cast-iron chairs were fixed by wooden trenails on stone blocks about 2 feet square, 1 foot thick, and 3 feet apart. This practice is

supposed by many authorities to have been originated by Outram, and certain it is that he favoured and used this method to a great extent. A typical example of these stone blocks with a chair to support the rail was that of the Stratford-upon-Avon and Moreton-in-the-Marsh Tramway opened in 1826. The permanent way of another small line, opened six years earlier, built for transporting granite from the Hey Tor quarries in the county of Devon is of great interest, as the track consisted of granite blocks about 6 feet in length, cut in a similar manner to the plate-ways made of iron which at that time existed in many parts of the country. The remains of this unusual form of permanent way were visible at certain places on the old tramway a few years ago. These stone blocks served their purpose when speed was slow and traffic light, as it was bound to be with horse traction, though even at that time it appears that a considerable amount of trouble was experienced in keeping the rails the required distance apart. This is proved by the deep grooves worn in some rails used during the first decade of the nineteenth century on a North of England colliery line. On many of these early tram-lines it was found necessary to cover the wooden cross-ties with earth or stone so as to prevent the damage done by horses' hoofs. This reason, probably, explains the preference for stone sleepers, as, for instance, used on the Silkstone Railway in 1809 and on the Kilmarnock and Troon in 1811; but with the coming of the locomotive, the necessity of keeping the gauge exact was such that reversion had to be made to the wooden or metal cross-tie, and cast-iron appears to have been a material used on many of the early lines for this purpose.[1]

Oak sleepers were used on the Liverpool and Manchester Railway where the line was constructed on an embankment, but in cuttings stone blocks 3 feet apart were employed. A similar system seems to have been adopted on the Leeds and Selby Railway, where stone blocks and larchwood sleepers were both in existence.

[1] The Leeds and Selby Railway is known to have been using cast-iron sleepers in 1835.

The adjoining Manchester and Leeds in 1840 also used larchwood sleepers on embankments and stone sleepers in cuttings. This line seems to have been the first in the world to employ sleepers treated with a solution to avoid rotting. The Manchester, Bolton, and Bury apparently employed longitudinal stone sleepers on certain sections and on the remainder of the line longitudinal timber baulks attached to cross-ties.

With the wide 7-foot gauge of the Great Western in Brunel's day it was necessary to find some method of avoiding the use of long cross sleepers and the expenditure which would thus be incurred. It was thought by many of the early engineers that a road-bed should be as rigid as possible. Consequently an interesting departure from the usual transverse sleeper practice was made by Brunel, when he adopted a longitudinal type of sleeper upon which a light rail of bridge-design rested, the gauge being kept exact by cross-pieces. On the conversion to the standard gauge, Brunel's system of longitudinal sleepers disappeared from the main lines, though short stretches of them may still be seen on sidings.

The Chester and Crewe of 1839, which had a gauge of 4ft. $8\frac{3}{4}$in., had part of its line laid on longitudinal sleepers, whilst its neighbour, the 4ft. 9in. Manchester and Birmingham of 1842, used longitudinal stone sleepers in cuttings and longitudinal baulks in other places, to which were added at a later date timber cross-ties, or sleepers. The Hull and Selby adopted the same system, but does not appear to have used stone sleepers.

During the first century of steam railway operation in Great Britain, many various kinds of woods, cast iron, steel, and concrete have been experimented with for use as sleepers. In at least one case stone blocks were tried again, but their unyielding nature was disadvantageous and wood is now practically universal; Baltic fir is the wood usually employed. Every sleeper, for which the standard size is 8ft. 6in. by 10in. by 5in., is bored to receive the steel screws, then impregnated with creosote, often to the extent of nearly 4 gallons. The treated sleeper, weighing some 150 lb., is finally fitted with chairs

and sent out of the stores to replace sleepers already in use. It must not, however, be supposed that no other material will ever replace wood. Tests are continually being made with concrete blocks; some of these spaced rather more than 2 feet apart, supporting flat-bottomed rails of 65 lb. and 80 lb. per yard, have met with considerable success on a west of England light railway, where loads do not exceed 14 tons per axle with the lighter rail, and the speed is not greater than 30 miles per hour. The blocks are kept to proper gauge by means of metal tie-rods; some of these are now being tried experimentally on the main line of the L.N.E.R.

In 1919 a test was made on the North Eastern Railway of steel sleepers carrying 100 lb. per yard flat-bottomed rails, but no results of this experiment have so far been published. Abroad, similar experiments are made from time to time; one noteworthy example was that of the Belgian State Railways which in 1905 tested concrete sleepers, compressed with metal bands, which in turn were coated with a thin layer of concrete. In America and Canada hard-wood sleepers are almost universal, though concrete and metal have often been tried, but so far without conspicuous success, and it is now becoming the practice to impregnate the wooden ones before use in the road-bed. On the Continent of Europe, hardwood and metal are both used extensively but the general preference appears to be for the former; the difficulty of bonding rails with metal sleepers is a considerable disadvantage to the use of that material. In the East, both metal and wood have been used extensively, but the final choice is often dependent partially on the general design of the track in use and partially on local conditions such as the presence of white ants.

The sleepers rest upon a ballast bed and are not covered with the ballast, as in the old days of horse tramways. Specifications for the standard formation of a road-bed vary considerably between the different Railway Companies, but the main characteristics of any ballasting material are that it should be hard and clean, and not liable to disintegrate under the action of weather and so

prevent the complete percolation of water whereby the permanent way is drained. Stone, often granite, or slag, broken sufficiently to pass through a 2½-inch ring, but not through a ¾-inch ring, is the usual ballasting material; though some lines, such as the London and North Western, used a top dressing of smaller stones. The main function of the whole road-bed design is to spread the weight as evenly as possible, and the method of packing together with the care with which this is done, contributes largely to the smoothness of running and consequent reduction of wear and tear to rolling stock, and to low maintenance charges.

The depth of the road-bed varies in accordance with the individual practice of the railway concerned and also in accordance with the amount and weight of the traffic which is expected to pass over the piece of track; but 14 inches may be regarded as a fair average depth, and the formation must be sloped to ensure draining the water outwards from the track. A space of 6 feet is always left between each pair of rails and has come to be known as the "six-footway," as opposed to the "four-footway" over which run the trains. Abroad, where the loading gauge is wider, the "six-footway" is often considerably widened.

On certain electrified sections of line departures from main line practice have been made, though the permanent way of the Metropolitan and the Metropolitan District Railway is virtually the British standard design. The sleepers of tube railways in London, which are built on a rigid track, are unsupported for a width of about 3 ft. 6 in. in their centres, the end supports softening the running by means of this cantilever method. The Central London uses the bridge type of rail, those on the curves weighing 100 lb. per yard. The wear and tear to which these electric railway rails are exposed is so continuous that at certain places they have to be replaced at least once a year, but the use of more expensive manganese steel for crossings is becoming common, longer life offsetting the extra cost. One effect of electric traction is to cause uneven wear. Running diagrams are

frequently taken on such lines as the Metropolitan District, and there assist the permanent way staff to adjust faulty rail joints, each bump being recorded on the graph and records taken from the same car being compared over certain periods of time.

Continual changes are always being made and will always continue to be made in the design of the roadbed. With heavier locomotives, increased axle-weight, and faster and more frequent traffic, every effort has to be made to strengthen the permanent way. It is generally admitted that in questions of permanent way construction and maintenance the British railways are pre-eminent. The reduction of wear and tear to rolling stock and the increase of comfort attained probably outweigh any added first cost and maintenance.

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CHAPTER VIII

DEVELOPMENT OF THE STEAM LOCOMOTIVE

Although Watt in his workshop at Birmingham had employed steam as a source of power, to Trevithick belongs the honour of first utilizing it as a means of propelling a vehicle upon wheels. Richard Trevithick's steam carriage first appeared in Cornwall in 1802, and was brought to London in the same year. Two years later in South Wales, Trevithick, in co-operation with his cousin Vivian, experimented on the Merthyr Tydvil Railway with a steam locomotive. This engine possessed a flywheel after the manner of a modern steam roller, and power was applied to all the four wheels of the engine. The track of those early tramways, designed for horse traction, failed under the unaccustomed weight of a steam locomotive, with the result that Trevithick was finally discouraged from building further locomotives.

The fear that lack of adhesion would prevent the pulling of a load led John Blenkinsop, in 1811, to design a rack railway which appears to have been successful for the transport of coal at a low rate of speed. Nearly two years later, William Hedley improved on this rack railway by coupling his two axles together by gears, so that the total weight was available for adhesion. This engine was known as "Puffing Billy," and it is believed that Timothy Hackworth, who later was connected with the Stockton and Darlington Railway, assisted Hedley in its construction. In the following year, 1814, George Stephenson, who had studied the three engines which had been working at Wylam, a Trevithick, a Blenkinsop, and Hedley's "Puffing Billy," designed at Killingworth his first steam locomotive, which was known as the "Blucher"; its trials took place on July 25th, when it

drew a 30-ton load at 4 miles per hour up a gradient of 1 in 450. This engine was later fitted with a vertical steam exit pipe up the chimney, which assisted the furnace very considerably. It is believed that the same system had been used by Richard Trevithick some years before. An additional advantage was that the long smoke stack tended to prevent the frightening of horses and cattle by the escaping steam. In 1815 Stephenson produced the prototype of the present day locomotive ; his engine of that year possessed the steam blast and a horizontal connecting rod which avoided the earlier complicated system of gears to transmit the power of the cylinders to the wheels.

When it had been decided finally to adopt steam locomotives as the source of tractive power on the Stockton and Darlington Railway, George Stephenson, who was responsible for the construction of the line, also contracted to supply the first locomotives. Hackworth later assisted Stephenson by looking after the maintenance of this railway's engines. On September 27th, 1825, the first steam locomotive engine, No. 1, of the Stockton and Darlington Railway, later named " Locomotion," was driven by George Stephenson, from the foot of Brusselton Incline to Darlington and Stockton, with two of his brothers acting as firemen. The train consisted of thirty-five wagons behind the engine and tender, and the Company's coach, known as the " Experiment," in which travelled the Committee and other proprietors. The train is recorded as having attained nearly 15 miles per hour, and but for the cutting off of a wagon filled with surveyors and engineers, which became derailed twice, the opening run proved a great success. Horsemen and a stage coach, which had attempted to race the new locomotive, were passed in the course of the journey from Brusselton to Stockton. No. 1, " Locomotion," was one of the first engines built at Stephenson's works at Newcastle, whence it was despatched to the Railway Company and placed upon the rails at Aycliffe. It is believed that on the first occasion its fire was lighted by means of a burning glass. " Locomotion " was a four-wheeled

(0–4–0) engine, and is still in existence, being the centre of admiration at the recent celebrations of the centenary of the opening of the Stockton and Darlington Railway. It is thought that "Locomotion," No. 1, carried a pressure of about 25 lb. per square inch, and weighed in working order about 8½ tons. After the arrival of the three sisters, "Hope," No. 2, "Black Diamond," No. 3, and "Diligence," No. 4, two six-coupled (0–6–0) engines, "Experiment," No. 5, and "Royal George," No. 6, commenced working in 1827, while "Rocket,"[1] No. 7, and "Victory," No. 8, both 0–6–0's, followed in 1829, the next two being "Globe," No. 9, and "Planet," No. 10.

When the choice had to be made of the new type of power to be used on the Liverpool and Manchester Railway, it was a question of stationary engines or locomotives, and the directors offered a prize of £500 for the best locomotive submitted, the locomotive having to draw 20 tons weight at 10 miles per hour, and worked at a pressure not exceeding 50 lb. per square inch. In October, 1829, the trials of the competing locomotives were held at Rainhill, near Liverpool. There were five competitors: the "Novelty," entered by Ericson and Braithwaite; the "Rocket," by George and Robert Stephenson and Henry Booth; the "Cyclopede," by Brundrath; the "Sans Pareil," by Hackworth; and the "Perseverance," by Burstall. The "Novelty" had to be withdrawn owing to a defect at the time of the trials, and Hackworth's "Sans Pareil" also developed defects. The "Rocket" is reputed to have attained 29 miles per hour, with an average of 15 miles per hour. This achievement settled the supremacy of the steam locomotive as the main source of power on the world's railways for a hundred years.

The "Planet" was the first locomotive fitted with inside cylinders, and was used on the first freight train from Liverpool to Manchester in December, 1830. The "Rocket," the "Planet," and other Liverpool and Manchester Railway locomotives were mounted on four wheels only. Thus, as early as 1830 two types of locomotives

[1] Not to be confused with the "Rocket" of the Rainhill trials

existed: the large-diameter-wheeled type for passenger service, and the six-wheeled type with smaller diameter wheels for freight and mineral service. To simplify the descriptions of the various types of locomotives, it is proposed in this chapter to adopt the system of classification by wheel arrangements, the first numeral referring to the number of carrying axles in front of the driving wheels, the second number referring to the number of driving axles, and the third to the number of carrying axles in the rear of the driving axles. A complete table showing the various wheel arrangements will be found at the end of this chapter.

The six-coupled type (0–6–0) still remains the standard freight and shunting engine design on at least one large British line. The four-coupled locomotive of modern times possesses a four-wheeled bogie in advance of its coupled wheels, and, in some cases, a trailing axle in rear of them, the principle of the two-coupled axles tracing its ancestry back to the days of the Stephensons. With the gradual improvements effected in the manufacture of the locomotive, it became possible to increase the pressure of the steam per square inch, to increase the size of the cylinders, add to the heating surface, and, as a consequence of these improvements, very considerably to raise the tractive effort of the machine.

The Stockton and Darlington's No. 9 engine, "Globe," is interesting as being the first engine built by a railway in its own works, this engine being built at Shildon Works in 1830. It is noteworthy that during the first decade of steam locomotive design, all locomotives carried their water supply and fuel on a wagon attached to the locomotive, known as the tender. At a later date provision was found for these very necessary stores on the engine itself. In cases where water tanks were placed behind the cab and carried on one or two trailing axles, the design was known as a "well-tank locomotive." Other designers placed the water tanks over the boiler; when rounded this is known as the saddle-tank design, but when square as the pannier-tank. A fourth type placed rectangular tanks at the sides of the boiler, resting

on the running plates, this type of tank engine being designated the side-tank. The main advantages of the tank-engine design are the reduction in length, which it allows, and also the greater ease of running in both directions, which makes it especially suitable for shunting and local passenger work. It is surprising that its great popularity in Britain has not extended abroad to places where operating conditions approximate fairly closely to those obtaining in this country.

On May 3rd, 1830, took place the opening of the Canterbury and Whitstable Railway, for which the Stephenson Works at Newcastle built a four-wheeled coupled engine called the "Invicta," which is still preserved. This engine had 10- by 18-inch cylinders, 4-foot driving wheels, and with a pressure of about 50lb. per square inch possessed a tractive effort of about 1,590lb. In 1833 there appeared upon the Dundee and Newtyle Railway the first engine constructed with a four-wheel bogie. This locomotive was named the "Earl of Airlie," and was the ancestor of a very numerous progeny which even to-day can be found at work all over Scotland. The main object underlying this four-wheeled swivel truck was to guide the larger-coupled wheels round curves. The famous "North Star," a broad-gauge single-wheeler (2–2–2) built by Robert Stephenson & Co. in 1837 for the London and Bristol, had 7-foot driving wheels, a boiler pressure of 80lb., cylinders 16 by 18 inches, and a tractive effort of 3,730lb. This veteran locomotive, which weighed 21 tons, possessed a boiler barrel of 4-foot diameter and a heating surface of 725 square feet. It remained in traffic until 1870.

In 1842 Robert Stephenson & Co., the locomotive builders, invented the valve gear now known as Stephenson's link motion, and some years later Walschaert invented the valve gear known by his name, which has recently been adopted as standard for all new steam locomotives by many of the leading railways of the world. For the opening of the Middlesbro' to Redcar branch of the Stockton and Darlington Railway in 1845, a six-wheeled locomotive with a single driving wheel was built,

which marked a new development on that railway, the latter having relied previously on coupled axles of the four- or six-wheeled type. George Stephenson, with the help of an assistant, William Howe, took out a patent for a three-cylinder locomotive in 1846, and "two engines of this design were built for the York, Newcastle, and Berwick Railway." [1] Carried on six wheels with the rear axle as the driving axle, these locomotives were the precursors of the present-day three-cylinder higher-pressure design mentioned later in this chapter.

Francis Trevithick, the son of Richard Trevithick, built at Crewe, in 1847, the famous single-wheeler "Cornwall" with the enormous driving wheels of 8ft. 6ins. As originally built, the boiler of the "Cornwall" was underneath the axle of its driving wheel, but in 1858 it was rebuilt with its boiler in the normal position. This engine is still in existence, though in a very different form to that in which it originally appeared, and is the only British locomotive regularly in steam dating back to the forties, being used for many years as the saloon of the Chief Mechanical Engineer of the London and North Western Railway. It possesses a boiler 4 feet in diameter and in its present condition a tractive effort of 8,740lb., weighing just over 56 tons. In 1848, a single-wheeler (2–2–2) was built for the Great Northern Railway, possessing cylinders 15 by 20 inches, a heating surface of 748 square feet, and a tractive effort of 4,636lb., the weight of the engine without tender being about 18½ tons; it was this type of engine and its later successors that earned for the Great Northern its famous reputation for speed.

"Lord of the Isles" was a famous bogie single-wheeler (4–2–2) built by the Great Western Railway at Swindon in 1851, with cylinders 18 by 24 inches, 8-foot driving wheels, a boiler pressure of 140lb., and a tractive effort of 9,640lb.; it proved to be one of the most noted of the broad-gauge engines.

[1] *The Three-Cylinder High-Pressure Locomotive.* A paper read by H. N. Gresley, C.B.E., before the Institute of Mechanical Engineers, Newcastle-upon-Tyne, July, 1925.

By 1854 the 2–4–0 type of locomotive had reached the northern part of Scotland, this design being adopted for the early Great North of Scotland engines in 1854, the need for increased adhesion on lines of heavy gradients and sharp curves making the single-driving axle unsuitable for most Scottish lines. It was during the fifties that attention was first given to providing the enginemen with some means of protection from the weather; this first consisted of a weather board, later a short roof was added, stretching back a foot or two over the footplate, then side sheets were added, and to-day cabs on many locomotives are scientifically ventilated, fitted with windows and seats, giving ample protection, when running forward, from inclement weather. An important appliance fitted to the steam locomotive was invented by Ramsbottom in 1860, enabling the water to be picked up at speed from water troughs; thanks to the even climate in England, this apparatus has saved the haulage of many thousands of non-revenue producing ton miles every year. In 1859 the invention of the injector by Giffard was a great achievement in the progress of the locomotive.

In 1861 the 4–4–0 type made its appearance on the Great North of Scotland, and from that date until the railway's absorption in the L.N.E.R. no four-coupled passenger locomotives were built for this line without four-wheeled bogies. The early sixties saw an interesting development on the Great Northern Railway, where Mr. Sturrock, in order to increase the power of his locomotives without adding to the axle weight, invented a steam tender on which a pair of cylinders converted the centre axle of the tender into a power unit. The device does not appear to have been a success, but it is curious that the same idea, in the form of a booster, mentioned later in this chapter, reappeared experimentally on the Great Northern section of the L.N.E.R. in 1923. Ramsbottom of the London and North Western Railway was also responsible for a deservedly famous type of locomotive in the " Lady of the Lake " class of single wheelers (2–2–2) with 7ft. 6in. driving wheels, boilers of 4 feet in diameter, with a pressure of 120lb. to the square inch. In their

rebuilt state many of these lasted well into the twentieth century, proving ideal pilots to the Webb compounds of the eighties and nineties, and then doing, it is alleged, more than their fair share of the work.

In 1870 Stirling's bogie singles (4–2–2) appeared on the Great Northern Railway with their 8ft. 1in. driving wheels, 18- by 28-inch cylinders, a heating surface of 1,165 square feet, and a weight of about 38½ tons, with a tractive effort of 11,245lb. For the heaviest trains he built in later years a 2–4–0 type which permitted greater adhesion, the last representative of this latter type having only just disappeared from service. The famous "Precedent" class of four-coupled engines with leading radial axles started to appear from Crewe in 1871, but by the middle of the seventies the four-coupled bogie (4–4–0) express tender engine had achieved very considerable popularity, and in 1876 some very fine examples of this type were being turned out to Mr. Beattie's design for the London and South Western Railway. During this period the six-coupled (0–6–0) locomotive had become the standard type for the country's freight service; with rapid acceleration powers and its whole weight available for adhesion it may still claim to be the standard shunting engine type of to-day.

The seventies and eighties witnessed the arrival of the famous front-coupled designs of Mr. Stroudley for the London, Brighton, and South Coast Railway. Spick and span in their gamboge paint with copper-capped chimneys, no railway possessed engines more popular with the travelling public, and they must have added greatly to the net revenue of their line, not only by attracting added receipts, but also by their wonderful capacity for punctual running. Fortunately, through the co-operation of the Stephenson Locomotive Society, and the Southern Railway, one of the most famous of these machines, "Gladstone" (0–4–2), has been preserved in its original paint and condition at the Railway Museum at York, whilst some of its sisters are still at work, and many of the tank variety of the class still do notable work on suburban and branch line trains of the Southern Railway. The first

of the 0–4–2 tank class was turned out in 1873, so that some of them have completed fifty-five years of a strenuous life. Critics foretold that a front-coupled locomotive would suffer from endless derailments, but in practice the "Gladstones" have proved remarkably steady running engines and almost totally free from derailments, thus confounding the opinion of the critics.

The improvement of the exhaust injector, by Davies and Metcalfe, during the late seventies, was an important landmark in the growing efficiency of the steam locomotive. In 1878 Mr. F. W. Webb commenced his compounding programme at Crewe, which aimed at utilizing the steam in low-pressure cylinders after it had been used in the high-pressure cylinders, but his omission to couple the driving axles resulted in great difficulty in starting. The numerous types of compounds with two or three cylinders turned out from Crewe were scrapped in large numbers soon after the close of Mr. Webb's régime at Crewe, and only a few compound mineral engines (0–8–0) exist to-day, the remainder having been converted to two-cylinder engines of the simple expansion type.

By 1880 David Joy's radial valve gear had been invented and was for many years adopted as the standard valve gear at Crewe. "Charles Dickens," a famous Crewe product of the "Precedent" class, first saw the light in 1882 and earned fame by running between Euston and Manchester daily for twenty years. In 1907 this engine had run over 2 million miles; a sister engine "Hardwicke," in the races to Scotland in 1895, ran from Crewe to Carlisle at an average speed of 62·2 miles per hour. The year 1885 saw the introduction, by Mr. T. W. Worsdell, of the von Borries system of compounding on the Great Eastern Railway, but it was not destined to survive long on that line.

An interesting development of Webb's earlier three-cylinder compound arrived in 1891 with the "Greater Britain" class, with two sets of driving wheels, and leading and trailing axles (2–2–2–2). Conspicuous by their lengthy boilers, they cannot be claimed to have been successful machines. The introduction of the six-coupled

bogie (4–6–0) type into this country occurred on the Highland Railway three years later. Designed by Mr. D. Jones, these engines were primarily built for freight-train working, although the wheel arrangement has come to be regarded as very desirable at the present time for the most important express passenger work on three of our four big railways. Mr. Webb commenced to turn out from Crewe, in 1892, some of his eight-coupled (0–8–0) mineral engines, these being the prototypes of this wheel arrangement for tender engine design in Great Britain; this was the standard wheel arrangement for heavy mineral traffic engines on the London and North Western and the Lancashire and Yorkshire Railways until the formation of the L.M.S.R. Their greater adhesion as compared with the six-coupled type may enforce their use, equipped possibly with a leading carrying axle, for some years to come.

The first British locomotive with four simple cylinders was the four-coupled bogie express engine (4–4–0) built to Mr. Manson's design for the Glasgow and South Western Railway in 1896, while closely following was a similar type of engine designed for the London and North Western by Mr. Webb but converted to compound propulsion soon after being put into service. The year 1897 may be said to mark the beginning of a new era in British locomotive design, since, up to that year, development had largely been along the lines of enlarged cylinder capacity, but, henceforth, the tendency was to increase the size of the boiler. It is possible that the races to Aberdeen in 1895 may have had some bearing on this, as the Stirling singles on the Great Northern possessed large cylinders but small boilers, while the four-coupled bogie "Dunalastairs," to Mr. McIntosh's design on the Caledonian section of the West Coast Route, which acquitted themselves with great distinction, possessed very large boilers for their time.

Mr. W. H. Smith patented his system of compounding in 1898, and it may be said that this is the only system of compounding which has met with any large degree of success in England. The year 1898 also saw the intro-

duction of Mr. Ivatt's first Atlantics [1] (4–4–2) on the Great Northern Railway, and the following year the same type appeared to Mr. (now Sir) John Aspinall's design on the Lancashire and Yorkshire Railway. This development was a natural one from that of the four-coupled bogie type (4–4–0) which had previously been the standard express engine design in the country; the added trailing axle allowed a larger boiler and wider firebox, thereby considerably augmenting the available heating surface. Both these designs of 4–4–2 "Atlantic" type locomotives possessed larger boilers than previous express-engine types on their respective lines; and when Mr. Worsdell adopted a large boiler for his bogie six-coupled type of passenger engines (4–6–0) on the North Eastern Railway, the era of large boilers may be said to have started in earnest. The closing years of the nineteenth century and opening years of the twentieth saw the building of the last bogie singles (4–2–2) for British Railways; the Great Eastern, Great Northern, Great Central, and Midland each putting into service some engines of this type. But the lack of adhesion on slippery rails, a serious consideration for modern locomotives with heavy trains, has resulted in the withdrawal of all these locomotives after comparatively short careers, with the exception of about four of the Midland design.

In 1902 Mr. Ivatt's large boilered "Atlantic" type locomotives made their appearance on the Great Northern. These locomotives possessed boilers of exceptionally large diameter, namely 5ft. 6in., thereby obtaining a heating surface of 2,500 square feet. They had cylinders of $18\frac{3}{4}$ by 24 inches and weighing $68\frac{1}{4}$ tons developed a tractive effort of 15,690lb. In the same year Mr. Dean put into service the first six-coupled bogie express engine on the Great Western Railway; this engine proved to be the prototype of a large series of machines of the two-cylinder type. Named after "Saints," "Ladies," and "Courts," they are commonly referred to by these names. Four-cylinder locomotives of similar design were named

[1] Known as Atlantic because the design was first used on the Atlantic Coast Line Railroad of the United States in 1895.

"Queens," "Princes," and "Abbeys," and have figured largely in the twentieth-century locomotive history of this railway, being noted for high speeds and long-distance non-stop runs under the Churchward and Collett régimes at Swindon. A more recent development of this design is known as the "Castle" class, which will be dealt with more fully later on in this chapter, as will also the, presumably, ultimate development of the design which appeared in 1927 and is known as the "King" class. The year 1902 saw the arrival of the successful three-cylinder compound four-coupled bogie (4–4–0) express engines on the Midland Railway,[1] built to Mr. Johnson's design, which, though altered by Mr. Deeley, have been added to in large numbers during the last year or two.

The enormous three-cylinder "Decapod" (0–10–0) tank, built by Mr. Holden of the Great Eastern Railway, appeared in 1902, and, weighing 70 tons, carried a boiler pressure of 200lb. per square inch; this locomotive was converted later into an eight-coupled (0–8–0) mineral engine owing to the inability of the permanent way to carry it successfully; designed as a reply to electrification proposals it achieved a speed of 30 miles per hour thirty seconds from starting.

A further notable increase in boiler size occurred in 1903, when Mr. McIntosh's big boilered bogies (4–6–0) made their début on the Caledonian Railway. In 1903 another noteworthy event was the purchase by the Great Western of the French four-cylinder compound Atlantic (4–4–2) of de Glehn design, as still used on the Nord Railway of France. When tested against the G.W.R. 4–6–0 locomotives, however, the latter design proved the more satisfactory under British conditions; and although compound locomotives were built for the Great Central, North Eastern, and Great Northern Railways in the following years, some of these locomotives have since been converted to simples, while the others remain as the only examples of their respective types. The London, Brighton, and South Coast Railway adopted the Atlantic type (4–4–2) for its express passenger tender engines in

[1] These locomotives used the Smith system of compounding.

1905, the North British emulating its example in the same year. The North Eastern Railway, which had adopted the Atlantic type 4–4–2 for express passenger work at an early date, improved on this by converting it from a two-cylinder design to a three-cylinder design. The G.W.R. had tested Swindon built "Atlantics" against their six-coupled bogie express engines (4–6–0), but favouring the latter gradually converted their "Atlantics" into six-coupled engines in the course of the following years.

In 1908 a further important development occurred with the addition of superheater equipment to new locomotive designs, and the excellent performance of the London, Brighton, and South Coast Railway Atlantic type tank locomotive, fitted with a Schmidt type superheater, in competing with a London and North Western Railway four-coupled bogie (4–4–0) express tender engine between Brighton and Rugby, drew general attention to the efficiency of this system. The water consumption as well as the fuel consumption of the tank locomotive proved remarkably low.

During the first years of the twentieth century Dr. Wilhelm Schmidt, the pioneer of superheating, may have been said to have perfected the system, which consisted in fitting small tubes inside the fire tubes at the smokebox end so that the steam on its way from the boiler to the cylinders might be dried and reach the cylinders at a higher temperature. Various designs of this system are in use on the British railways to-day with many variations in the degree of superheat, from the Swindon type to the Robinson and Schmidt types, but the success of the principle cannot be doubted, seeing that all modern express engines and a great many freight and mineral engines are now fitted with this appliance. Many older engines are so fitted when reboilered. Superheated steam possesses a higher temperature for the same pressure and greater volume with a lesser density.

The first engine of the Pacific [1] (4–6–2) type to appear

[1] Though the type was first used in New Zealand it was named as a result of its use on trains of the Missouri Pacific running between Chicago and the Pacific Coast.

in England was "The Great Bear," of 1908, designed by Mr. Churchward for the G.W.R. This notable engine, on account of its long wheel base and exceptional weight, was found unsuitable for work on many sections of the G.W.R., and has recently been converted into a 4–6–0 four-cylinder engine of the "Castle" type; it is of interest that in its latter and smaller state it is more powerful if measured by tractive effort than it was when running as a "Pacific." The year 1908 also saw the arrival of a remarkable three-cylinder tank locomotive of unique wheel arrangement, namely, eight-coupled with a trailing bogie (0–8–4) on the Great Central Railway, designed by Mr. Robinson for service in the hump marshalling yard at Wath, which deals with the large South Yorkshire coal traffic. This wheel arrangement was reversed when Mr. Worsdell introduced three-cylinder tank locomotives for marshalling yard service on the North Eastern Railway with a 4–8–0 wheel arrangement in 1909.

The movement in favour of the six-coupled bogie (4–6–0) type for express engines, whether of three or four cylinders, had gathered considerable momentum by this time. The Lancashire and Yorkshire followed in 1909 the course adopted by the London and North Western and London and South Western Railways in 1905, and was itself followed by the Great Eastern Railway in 1912. During the first decade of the twentieth century an interesting development was the construction of tender locomotives specially designed for mixed traffic work. In 1903 Mr. Webb had turned out at Crewe some 4–6–0 type compound engines with small diameter driving wheels designed for fast freight or slow passenger work. Simple engines of the same wheel arrangement afterwards appeared on the London and South Western, London and North Western, Great Central, Caledonian, and North Eastern Railways.

The G.W.R. in 1911, however, to achieve the same purpose, turned out a numerous series of "Mogul" (2–6–0) type engines to Mr. Churchward's design, while the first of Mr. Gresley's two-cylinder engines of the same wheel arrangement were put into service on the Great

Northern Railway the following year. Four other railways have since followed suit—the London, Brighton, and South Coast, the South Eastern and Chatham, Caledonian, and Glasgow and South Western Railways; whilst since the formation of the four grouped Companies three have perpetuated their own designs, and the L.M.S.R. has placed in service a new "Mogul" type. The number of this type of engine has recently been considerably extended, their "maid-of-all-work" character being peculiarly useful in coping with post-war conditions, where, due to the shortened working day, locomotive links often include an outward fast passenger trip and a return trip on a semi-fast freight or even a mineral train.

In 1918 Mr. Urie designed some six-coupled bogie (4–6–0) express engines for the London and South Western Railway with remarkably large cylinders, and this type with modifications has been fixed as the recent standard for the Southern Railway in their "King Arthur" class locomotives which have revolutionized locomotive express running on the Dover, Brighton, Bournemouth, and Exeter main lines. The same year saw the advent of the three-cylinder "Consolidation" type (2–8–0) of eight-coupled mineral engines of Mr. Gresley's design on the Great Northern Railway. The engines possessed the designer's own valve gear by which the valve motion for the inside cylinder is obtained from the working of the valve gears of the two outside cylinders. These engines were followed in 1920 by "Mogul" (2–6–0) type engines intended for both passenger and freight work in which the same three-cylinder propulsion method is employed.

During the ten-year period from 1910 to 1920 considerable developments were made in tank-engine designs. During the first decade of the century tank engines of the eight-coupled (0–8–2 T) type had appeared on the Great Northern Railway, and six-coupled (2–6–2 T) tank engines with leading and trailing axles on the Great Western and Lancashire and Yorkshire Railways. The London and North Western and Great Western Railways had also turned out tank engines of almost similar design to their express passenger tender engines by replacing the tender

by a trailing axle, but 1910 and 1911 saw the production of six-coupled bogie tank engines (4–6–2 T) all fitted with trailing axles on no less than three railways, and all primarily built for fast passenger traffic and fitted with superheaters. The London and North Western and Great Central Railways favoured the inside-cylinder design, the London, Brighton, and South Coast Railway and the Caledonian Railway, which followed suit six years later, favoured the outside-cylinder design. "Baltic" type (4–6–4 T) tank engines appeared for use on the Tilbury line in 1913, to be followed by a similar design with outside cylinders for the London, Brighton, and South Coast in 1914, while after the period of war stagnation other examples of this wheel arrangement, which permits a large supply of fuel and water, appeared on the Furness, Glasgow and South Western, and Belfast and County Down (Ireland) Railways. Recent tank-engine types have included the 4–4–4 T, 4–8–0 T, and 2–6–4 T wheel arrangements, the last named on the Southern and L.M.S. Railways.

During 1922 Mr. Gresley brought out his Pacific (4–6–2) design of three-cylinder express engine for the Great Northern Railway. As successors to Mr. Ivatt's large "Atlantic" these new "Pacifics" possessed 6ft. 8in. driving wheels, three cylinders 20 by 26 inches, a heating surface of 3,455 square feet, pressure of 180lb., and weighing 92½ tons exclusive of tender, develop a tractive effort of 29,835lb. The tapered boiler of this machine had a diameter of 6ft. 5in. at its largest part. These locomotives are fitted with superheaters and were designed to haul 600-ton trains on the L.N.E.R. main line to Scotland, a line possessing long adverse gradients on which their copious heating surface stands them in good stead. Recently one of their number has been fitted with a boiler of 220lb. per square inch, and it is understood that a new series under construction will also embody this feature. There would appear to be a certain connection between the success of these several types of three-cylinder engines and the prominence which has recently been given to three-cylinder propulsion for steam loco-

motives in the United States, which commenced in 1923 and has already extended to the Lehigh Valley, New York Central, and Rock Island lines. For lighter trains the L.N.E.R. put into service in 1927 a three-cylinder simple four-coupled bogie express type known as the "Shire" class.

The advantages of a three-cylinder high-pressure locomotive over the more usual two-cylinder type may be stated as including the following features. With more even movement there results a reduced coal consumption, less tyre wear, and increased running mileage between the times they must needs pass through the shops for general overhaul. The stresses on the permanent way, in addition, are not so great, due to more even balancing and lighter reciprocating parts, while a more even starting effort is obtained and a lower permissible factor of adhesion. The main disadvantages are higher first cost and more intricate valve gear motion, but the latter has been partially overcome by the Gresley gear which is in use on the engines built to his design for the L.N.E.R., as well as being employed on other locomotives abroad.

The year 1925 saw remarkable further locomotive developments on the L.N.E.R., there being turned out to Mr. Gresley's design a "Mikado" [1] type locomotive (2–8–2) for heavy freight work fitted with a booster or auxiliary steam engine to work the trailing axle. It is surprising that this development has not achieved more success in Great Britain in view of its popularity in the United States where, during 1925, a booster working two axles has recently appeared on a "Lima" type locomotive of 2–8–4 design and boosters have also been fitted to tender wheels. Prior to 1925 only one booster had been at work, namely that fitted experimentally by Mr. Gresley to a Great Northern Railway "Atlantic" a year or two before that date. The second notable development has been the six-cylinder double unit "Garratt" locomotive of Gresley design with the

[1] So called because this wheel type was first used on the Nippon Railway in 1897.

2–8–0–0–8–2 wheel arrangement, which permits of a very large diameter boiler, namely 7 feet, and the enormous tractive effort of 72,940lb., although the weight per axle is not excessive, being just over 18¼ tons. The L.N.E.R. "Garratt" is employed on the heavy gradients of the Worsboro' branch between Wath and Penistone.

The L.M.S.R. has also put into service some "Garratt" type locomotives for hauling heavy coal trains of 1,500 tons between Toton siding in Derbyshire and Brent sidings near Hendon, a distance of 126 miles, with a ruling gradient of 1 in 200, the actual running time requiring only 7 hours 50 minutes. These engines pick up water *en route* and have eliminated double heading on these trains, possessing a tractive effort of 45,620lb. The "Garratt" design enables a very powerful engine to be developed with low axle loading, an important consideration in the case of the Midland division of the L.M.S.R. The heaviest express passenger axle loading of to-day is that of the G.W.R. "King" class which amounts to about 22½ tons per axle.

The "Mallet" type of locomotive, whereby two separate power units are supplied from a single boiler, thereby easing its movement on curves at the same time as increasing the power, has been favoured under certain conditions on heavy traffic lines in the United States, such as the Erie. It has, however, never met with appreciation in the United Kingdom, and it seems unlikely that it will ever be required if the "Garratt" type should prove a success in practice.

Recent Great Western practice has centred on high-pressure locomotives of the six-coupled bogie type with four cylinders and simple expansion for express passenger services. The "Castle" class developed a tractive effort of 31,625lb. with a boiler pressure of 225lb., driving wheels 6ft. 8½in. and four 16- by 26-in. cylinders, but the ultimate design of this class is the "King" type. This issued from Swindon in 1927 and created great fame for itself by visiting the "Fair of the Iron Horse" near Baltimore, which celebrated the centenary of the Baltimore and Ohio Railroad in 1927. The following table

shows the evolution of this four-cylinder design, to-day the most powerful express passenger locomotives in the British Isles if measured by tractive effort.

TABLE VI.—Evolution of G.W.R. Four-cylinder Design

Total length Engine and Tender.	Weight in Working Order.		Total.	Tractive Effort.
	Engine.	Tender.		
"The Great Bear" Type, 4–6–2.				
ft. in.	tons. cwt.	tons. cwt.	tons. cwt.	lb.
71 2¼	97 0	45 15	142 15	27,800
"Star" Class Type, 4–6–0.				
ft. in.	tons. cwt.	tons. cwt.	tons. cwt.	lb.
64 1½	75 12	40 0	115 12	25,085 and 27,800
"Castle" Class Type, 4–6–0.				
ft. in.	tons. cwt.	tons. cwt.	tons. cwt.	lb.
65 1¾	79 17	40 0	119 17	31,625
"King" Class Type, 4–6–0.				
ft. in.	tons. cwt.	tons. cwt.	tons. cwt.	lb.
68 2	89 0	46 14	135 14	40,300

The "King" class possess four cylinders 16¼ by 28 inches and coupled wheels of 6ft. 6in. diameter. The boiler pressure is no less than 250lb. per square inch, and the heating surface amounts to 2,514 square feet with a grate area of 34·3 square feet. Designed primarily to avoid double heading with heavy trains on the banks between Newton Abbott and Plymouth, they have acquitted themselves with excellence both as regards speed and haulage capacity.

For main line freight and mineral trains two-cylinder "Moguls" (2–6–0) and "Consolidations" (2–8–0) have been adopted: whilst for tank engines varied wheel

arrangements such as two-cylinder simple 2–8–0's and 2–6–2's are employed. Both of these types, as with all modern engines of the G.W.R., possess outside cylinders, although an exception has recently been made in the case of a side-tank engine of 0–6–2 design which possesses inside cylinders and perpetuates the wheel arrangement used to such a large extent on the various South Wales mineral lines, in which area large numbers of the 2–8–0 type are also employed.

The L.M.S.R. has concentrated on three-cylinder compound four-coupled bogie (4–4–0) engines and three-cylinder simple six-coupled bogie (4–6–0) engines for express passenger work. This latter design by Sir Henry Fowler, known as the "Royal Scot" class, possesses three cylinders 18 by 26 inches, with coupled wheels of 6ft. 9in. and a boiler pressure of 250lb. per square inch. With a large heating surface of 2,081 square feet, a superheater of 445 square feet and a grate area of 31·2 square feet, these locomotives have been able to accomplish with ease the record non-stop runs of almost 300 miles to Carlisle. They possess a tractive effort at 85 per cent., boiler pressure of 33,150lb. and weigh 127½ tons, the weight of the driving axles not exceeding 21 tons. Their low fuel consumption can be claimed as one of their most successful attributes, working out at only 40lb. per mile, on the Carlisle run, with trains of 430 tons, according to figures made public by Sir Henry Fowler recently before the Institution of Mechanical Engineers.[1]

The Southern Railway, however, has been mainly putting into service two-cylinder six-coupled bogie locomotives for express trains, though the latest engine likely to become the standard for express passenger traffic possesses four cylinders. This famous locomotive which has already earned a place for itself in the history of the country's locomotive development has been named the "Lord Nelson," and was for many months Great Britain's most powerful passenger express engine, if tractive effort

[1] "Some Experimental Results from a Three-cylinder Compound Locomotive." L. H. Fry. A paper read before the Institute of Mechanical Engineers, December 10th, 1927.

be the basis of measurement. Designed with 6ft. 7in. coupled wheels to deal with 500-ton trains at an average speed of 55 miles per hour, it was completed to Mr. Maunsell's design at the Southern Railway's Eastleigh works in 1926. With four cylinders using simple expansion steam of $16\frac{1}{2}$ by 26 in., four Walschaert valve gears are employed, the drive of the four cylinders being noteworthy in that it is divided between two axles giving eight separate impulses to the wheels owing to the angles of the cranks, thus obtaining a more even firebox draught which should cut down maintenance costs, coupled with a more uniform torque, thereby attaining smooth running and reducing strains on the locomotive and the track. The high boiler pressure of 220lb. per square inch together with a Belpaire firebox and superheat ensures great reserve of power. With its sisters now under construction and in company with the two-cylinder " King Arthurs " the S.R. is destined to take a leading place in the country's locomotive performances. For fast freight work Mr. Maunsell has concentrated upon two-cylinder engines of the same general design as the " King Arthurs," but with smaller diameter wheels, in addition to his earlier " Moguls," and for lighter passenger work a powerful design of four-coupled bogie engine with light axle loading. The problem of locomotive design has been much more difficult on the S.R. than in the case of the other groups, owing to the lighter axle loading permitted on some of the main lines, notably on the Eastern Section.

It will thus be seen that of the four lines, one has developed the three-cylinder simple method with great success, and in that respect Great Britain probably leads. Two railways apparently favour the four-cylinder simple type of six-coupled engine with leading four-wheeled bogie, whilst the fourth line relies on a three-cylinder simple of the same wheel arrangement for the heaviest work, and a three-cylinder compound with two-coupled axles for lighter work. It will be noticed that 1927 was a most remarkable year for British locomotive development, each of the new types proving very successful, especially with regard to speed and haulage capabilities

coupled with remarkably low fuel consumption. To reduce the last still further experiments were conducted by the L.M.S.R. with the Caprotti valve gear and by the L.N.E.R. with the Lentz valve gear.

British steam locomotive design is still as pre-eminent as it was one hundred years ago, which bodes well for the future, but its position has been vigorously attacked by the electric locomotive, and experimental turbine and internal combustion engines have been constructed. The main development is likely to occur in the steady increase in boiler pressure, as witnessed by the latest designs on all four railways ; it is noteworthy in this respect that the new " Pacifics " now building are to be fitted with higher pressed boilers of 220 pounds. Infinite possibilities rest with such types as the " Garratt," though at the present moment it is not easy to foretell the date when the country's crack expresses will be hauled for the greater part of their run by steam locomotives of this design.

Closely allied to the growth in power and general improvement of the steam locomotive is the problem of how to measure the power which any given design develops. Accurate measurement is an essential if maximum operating efficiency is to be obtained, and there is considerable variation in the methods employed to classify and rate locomotives for loading purposes. Although no one system supplies the answer, because many aspects such as the length of rising gradients must be taken into account, measurement of tractive effort is commonly employed. To obtain this the following formula is used, namely, for a two-cylinder simple-expansion locomotive, the tractive force at the rim of the driving wheel

$$= \frac{(\text{Diameter of cylinders})^2 \times \text{Stroke of cylinders} \times \text{P}}{\text{Diameter of driving wheels.}}$$

Tractive effort is really the tractive effort per pound of effective steam pressure in the cylinders, which may be taken at 75 per cent., 80 per cent., or even 85 per cent. of nominal pressure per square inch, hence the necessity for multiplying by P which may be 75 per cent., or 80 per cent., or 85 per cent. of the nominal pressure. The

diameters and the stroke figures are reckoned in inches; in the case of four-cylinder simple-expansion engines the figure must, of course, be doubled, and for a three-cylinder simple-expansion engine have 50 per cent. added.

The following table shows comparative data for the most recent types of express passenger locomotives of the four British railways :—

TABLE VII.—Recent British Express Locomotive Engines

Railway.	Type.	Date.	Steam Pressure.	Tractive Force.
G.N.R. . . .	4–6–2	1922	180 lb.	29,835 lb.
N.E.R. . . .	4–6–2	1922	200 lb.	29,918 lb.
G.W.R. . . .	4–6–0	1923	225 lb.	31,625 lb.
S.R.	4–6–0	1926	220 lb.	33,500 lb.
L.M.S.R. . .	4–6–0	1927	250 lb.	33,150 lb.
L.N.E.R. . .	4–6–2	1927	220 lb.	36,465 lb.
G.W.R. . . .	4–6–0	1927	250 lb.	40,300 lb.

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TABLE VIII.—Wheel Arrangement of Tender Engines

Description.		Name.	
o O	Four-wheeled single . .	Planet	2–2–0
O O	Four-wheeled, four-coupled	—	0–4–0
o O o	Six-wheeled single . .	—	2–2–2
o o O o	Bogie single	—	4–2–2
o O O	Six-wheeled, four-coupled	—	2–4–0
O O o	Six-wheeled, front-coupled	—	0–4–2
O O O	Six-coupled	—	0–6–0
o o O O	Eight-wheeled	America	4–4–0
o o O O o	Four-coupled, leading bogie trailing axle	Atlantic	4–4–2
O O O o	Six-coupled, trailing axle.	—	0–6–2
o O O O	Six-coupled, leading axle.	Mogul	2–6–0
o o O O O	Six-coupled bogie . . .	Ten-wheeler	4–6–0
o O O O o	Six-coupled, leading and trailing axles . . .	Prairie	2–6–2
o o O O O o	Six-coupled, leading bogie and trailing axle . .	Pacific	4–6–2
o o O O O o o	Six-coupled, leading and trailing bogie . . .	Baltic	4–6–4
O O O O	Eight-coupled	—	0–8–0
o O O O O	Eight-coupled, leading axle	Consolidation	2–8–0
o O O O O o	Eight-coupled, leading and trailing axles . . .	Mikado	2–8–2
o o O O O O	Eight-coupled, four wheel bogie	Mastodon	4–8–0
o O O O O o o	Eight-coupled, leading axle and trailing bogie . .	Lima	2–8–4
o o O O O O o o	Eight-coupled, leading and trailing bogie . . .	Northern	4–8–4
O O O O O	Ten-coupled	Decapod	0–10–0
o O O O O O	Ten-coupled, leading axle.	Decapod	2–10–0
o O O O O O o	Ten-coupled, leading and trailing axles . . .	Santa Fé	2–10–2
o O O O O O o o	Ten-coupled, leading axles, trailing bogie . . .	Texas	2–10–4
o o O O O O O o	Ten-coupled, leading bogie, trailing axle	Southern Pacific	4–10–2
o o O O O O O O o	Twelve-coupled, leading bogie, trailing axle	Union Pacific	4–12–2

CHAPTER IX

CARRIAGE DESIGN

Although the Stockton and Darlington Railway had primarily been built for mineral and general merchandise traffic, the directors, possibly that they themselves might ride in greater comfort during the inaugural run, appear to have had a coach constructed, so designed as to run upon the rails rather than upon a road. Somewhat of mystery still attaches to the design of this so-called coach, certain early railway historians describe it as closely akin to a shepherd's hut on wheels with a small window-hole on each side, others as an ordinary road coach adapted to run upon the 4ft. 8½in. gauge. It appears certain, however, that it possessed end and not side doors and that seats were provided longitudinally and not transversely. Though no measurements of this vehicle are extant to-day, a model of its successor exists in the South Kensington Museum, and it is certain that it was appropriately named "Experiment."

From contemporary accounts it is clear that the development of passenger traffic by rail was quite a surprise to the Stockton and Darlington directors, and it seems likely that they adopted the expedient of adapting ordinary coach bodies to railway use, by the alteration of axles and flanged wheels in conjunction with buffer beams and couplings. For some years on this railway road coaches fitted to run on the rails were drawn by horses to provide a passenger service. Hence naturally followed the giving of such names as "Union" and "Experience" to individual railway carriages. For many years this ancestry of the earliest passenger carriages influenced railway-carriage design, and even to-day they are often called passenger coaches in Great Britain. The

Liverpool and Manchester Railway provided for passenger traffic, originally offering no choice of classes, but by 1833 it had put into service special mail coaches carrying twelve persons at a fare higher than first class.

Soon after the commencement of passenger travel by rail it became realized that not only first but second-class passengers were likely to provide an important part of railway revenue, with the result that the degree of comfort was increased, and on the Manchester and Bolton Railway, which may be taken as typical, second-class passengers were provided with cover, though the sides of the carriages were left open ; seats were placed round the sides and down the centre. The wheels were almost universally constructed of wood centres with cast-iron bosses and iron tyres. In the late thirties this railway in certain cases constructed the carriage underframes, on which were mounted bodies supplied by the road-coach builders.

A representative first-class carriage, now nearly a hundred years old, of the Bodmin and Wadebridge Railway, can be seen to-day in Waterloo Station. It illustrates well the descent of the railway carriages from the stage coach. These old Bodmin and Wadebridge carriages varied from 10 feet to nearly 15 feet in length, and weighed between 2 and 3½ tons, their width being about 6½ feet. It is of interest to observe that loose chain couplings only were used. A striking characteristic of the old carriages was their low clearance, in many cases the wheels came above the floor level and had to be boxed in as is the case with the tube cars of to-day. As early as 1836 a great improvement in comfort was obtained by the use of the screw coupling, which had been invented that year by Henry Booth.

As with passengers in the stage coaches which plied upon the highways, so on the railway only those passengers who paid the highest fares were provided with seats inside the coach ; these soon came to be known as first-class passengers, whilst second-class passengers were given outside seats during the first years of passenger rail transport. All others who cared to travel by rail had to do so in open wagons, and were discouraged from

travelling as far as possible. Some of these wagons were known as "Stanhopes" or "Standups," and were used on the Midland Counties Railway when it was first opened; they were practically the prototype of a 10-ton freight wagon. Their capacity of "stand ups" was about sixty-five, and they possessed four doors, and were divided longitudinally and across with wooden bars. This type of so-called wagon was in use on the Glasgow, Paisley, Kilmarnock, and Ayr Railway at the time of its opening, and also on the Manchester and Leeds Railway.

As with stage coaches, passengers could book their seats in advance, a system which was no doubt forced upon the railways by road competition; while in the forties the first-class coaches on the Manchester and Birmingham Railway were fitted with two road coach lamps on each side, between the three bow windows. This railway's carriages were noted for their comfort, since all the carriages, even the thirds, which were open, possessed spring buffers. The first and second-class carriages were further glorified by a brake which was operated by the guard, who sat on the roof, resplendent in top hat and complete with coaching horn.

On the neighbouring Manchester and Leeds Railway three-compartment carriages were also in use for first- and second-class passengers, those for the latter having open sides. This line was one of the first to use a composite or mixed carriage, with a first-class compartment in the middle and second-class compartments at either end. In 1840 there were some two-compartment third-class covered carriages without seats in service on this line, with a remarkable brake appliance manipulated from the roof, the brake levers themselves being connected to the axle box, and all four wheels being braked. Each first-class compartment was luxuriously fitted with an oil lamp and sash windows; while some vehicles of coach design appear to have been in use on this same railway with a centre first-class compartment and open-end compartments for second-class passengers. At this period it is clear that on nearly all lines, whether in England or

Scotland, the first-class carriages consisted of three compartments entirely closed, the seconds possessed roofs but no sides, and the thirds were usually open. One cannot but admire the ingenuity with which the Early Victorian railway managers succeeded in providing accommodation for forty third-class passengers in a carriage 17 feet in length and less than 7 feet in width.

With the coming of greater speed considerations of increased safety had to receive attention, whilst social progress demanded greater comfort. In 1840 the Great Western built their first Royal Saloon for Queen Victoria, and two years later the London and Brighton Railway built a special saloon for Queen Adelaide; the present Royal Saloons built by the London and North Western Railway in 1903 at Wolverton shops, themselves dating back to 1865, are probably unexcelled for comfort throughout the world, and are certainly not excelled in Great Britain.

The earliest carriages built especially for third-class passengers were entirely uncovered, but they were in due course fitted with roofs as a result of the Regulation of Railways Act of 1844, and finally with sides; but as late as the middle forties many third-class carriages existed without windows or lights of any kind. Their bodies were nearly always of wood, though at various periods, such as 1846, iron and papier-mâché had been tried. It is surprising to find South Eastern carriages of 1849 built to the width of 9 feet when so many modern carriages on the same line were limited to less than this by the narrow loading gauge.

The growth in carriage length has been steady from the earliest railway period, the "Experiment" of the Stockton and Darlington possessed one compartment; by the late thirties two-compartment coaches were in use, while in the forties three-compartment first-class coaches were being used on the Great Western Railway, and covered third-class carriages with open sides, but mounted on three axles in place of the customary two. The Great Western amongst others in its early days used different colours on the exterior of its carriages to distinguish the

various classes. This system is still in use on the Paris-Lyon-Méditerranée in France.

It was customary in many of these early designs to fit the carriage with one oil lamp in the centre, which was to serve as the source of illumination for all the three compartments of the carriage. Towards the end of the forties various methods came into use for communication with the guard or engine crew. These early systems mainly consisted in a cord carried outside the carriage, which rang a bell at one end of the train ; it was in connection with this method that the raised roof of the guard's van came into being, a feature which is still fairly common on the older carriages of the South Eastern section of the Southern Railway.

When in 1850 the Great Northern was opened to London it employed varnished teak carriages, which were a new departure, while the windows were raised by springs, a practice which did not prove a success. For some years after its opening it obtained carriages from private manufacturers, some of which provided, for a short time, accommodation for fourth-class passengers ; but in 1853 four-wheelers, 18 feet long and weighing 5 tons, were being built at Doncaster. These three-compartment vehicles with luggage rails in the roof were lighted by one oil lamp in each compartment.

By 1855 spring buffers had become almost universal, but many of the carriages were still four-wheelers, containing only three compartments ; a typical example may be taken from an Eastern Counties carriage 22 feet long and 8 feet wide, with seats for six first- and sixteen second-class passengers, while luggage was still carried on the roof ; grease was used as a lubricant for the axle boxes and side chains were provided. Considerable developments in length and inside height occurred in the early sixties, and a typical four-compartment four-wheel carriage of that date would seat thirty-two first- and second-class passengers on an empty, or tare, weight of 8 tons. The late sixties saw an important development in the use of rolled-steel beams in place of wood for carriage frames and sole bars. In 1867 the Great Western

Railway, which until then had obtained its rolling stock from outside firms, started to manufacture carriages and wagons in the Worcester shops of the old West Midland Railway, which it had absorbed, and two years later brought its own main shops at Swindon into use. The following year witnessed the passing of a regulation which made communication between passengers and the guard obligatory upon all trains travelling more than 20 miles without a stop, as a result of which the South Eastern and the London, Brighton, and South Coast Railways fitted their trains with electrical communication systems. It was not until the early twentieth century that the present system was adopted by which the automatic brake is applied if a passenger pulls the communication cord. In 1868 special compartments were set aside for smokers, as a result of a Railway Act passed that year.[1]

By 1871 the Great Western Railway was turning out from Swindon six-wheel coaches, 28 and 31 feet long, some of which contained all third-class compartments, while others were composites, that is, carriages containing compartments of various classes. The earliest London and North Western Railway six-wheel coaches were 30½ feet long, providing five third-class compartments 5ft. 10in. wide, while the first-class compartments had a width of 7 feet.[2] In 1874 the Great Western Railway constructed its first bogie eight-wheel carriages; by this method of construction, which is standard for railway practice almost throughout the world to-day, the two sets of axles at each end were pivoted so that although the two four-wheel bogie under-carriages might turn independently on a curve the carriage body itself remained rigid. The ease of travel around curves was thus greatly increased whilst the invention was of great importance in that it permitted the building of a much longer carriage and thereby reduced the tare weight, or weight of the carriage empty, per passenger seat.

Sleeping cars built by the Pullman Company of America

[1] 31 and 32 Vict., c. 119, s. 20.

[2] The width of a compartment is measured in the same direction as the length of the carriage.

were introduced on the Midland Railway in 1874, though a sleeping car was already in use on the West Coast route; carried on four-wheel bogies, they were 51½ feet long, and were without the end platforms at that time standard in the United States for nearly all passenger cars. Weighing about 21 tons, they were fitted with longitudinally arranged berths, a system which is still the normal practice in the United States to-day. These cars ran originally between St. Pancras (London) and Leeds, but, after the opening of the Carlisle–Settle line, ran through to Edinburgh and Glasgow. The trains on which they ran used to allow half an hour for dinner at Normanton, but in 1882 dinner was served on the cars themselves; cooking was done by coal and lighting by oil; thus as well as being the first sleeping cars they were almost the first dining cars to run in Great Britain, the first being run by the Great Northern Railway three years earlier between King's Cross (London) and Leeds. One of these old Pullman cars built in 1880 was only withdrawn from service in 1926, though its work in recent years had been of a very different nature. The Midland was also the first line to add third-class dining cars to its express trains.

The Midland Railway in 1875 began to construct 54-foot long bogie coaches with clerestory roofs to work on the Pullman trains. These carriages marked a great increase in comfort for the third-class passenger, especially when it is remembered that this progressive line had permitted this class of passenger to travel on its fastest trains.

It is curious that nearly all the British railways still use dining cars divided into first- and third-class compartments, or in some cases use a third-class diner in conjunction with a combined first-class diner and kitchen. In a few cases a triple unit of first-class and third-class diners and kitchen cars is in use. Abroad it is the normal practice to provide one dining car which is available to all passengers, a system which reduces operating costs to a minimum, and few complaints appear to arise from it.

Ever since 1876 Pullman cars have been used between

London and Brighton, and of recent years their use has been extended to other lines. Originally Pullman cars were mainly of the drawing-room design, and were tried on the London and South Western, and later on the London to Dover service, in the form of a club train. Neither of these latter proved successful. But in 1908 the famous "Southern Belle" ushered in a new era of prosperity for the Pullman Company, and new cars were introduced on the Continental boat trains of the South Eastern and Chatham Railway, and were very successful in offering a dining and buffet service with large seating capacity. The same year the Metropolitan put into service two Pullman cars on some of their city business trains, whilst just prior to the war, the Caledonian, and after the war, the Great Eastern Railways also began to run Pullman cars. In 1915 the first third-class Pullmans were put into service on the London, Brighton, and South Coast Railway, and have proved very popular. The London and North Eastern Railway since the amalgamation in 1923 has been running a Pullman service through from London to Edinburgh by way of Harrogate. The use of Pullman cars raises important economic considerations which will be dealt with when passenger train problems are discussed in a later chapter.

From 1881 onwards, when the Great Western Railway realized that the conversion to standard gauge would be finally inevitable, all passenger carriages were constructed with standard-gauge bodies mounted on broad-gauge axles; thus, when the change actually took place in May, 1892, the bodies were transferred to standard-gauge axles. In 1892 this same railway began putting into service carriages with lavatory accommodation, whilst in 1890 its first corridor carriages had appeared and ran on the "Cornishman." These carriages were some of the last built which included in their design the old coach type of bay window. Mounted on two four-wheel bogies, possessing a length of 50 feet and seating sixty-four persons in eight compartments, this notable design had clerestory roofs, a feature which was standard for carriage design for many years on the Great Western and Midland

Railways, and has been used at various periods on other British lines, notably the North Eastern and Great Eastern, but to a lesser extent. Designed to give better ventilation and undoubtedly adding somewhat to the interior appearance of the carriage, this design of roof is still standard in the United States and other countries where climatic conditions are more severe than in Great Britain. However, certain American railways, such as the Southern Pacific which traverses hot regions, have to some extent discarded it in favour of the semi-elliptical design which is the standard British and Continental practice of to day.

Trials were made with swivelling axles for six-wheeled vehicles, a system patented by Cleminson, and eight-wheeled carriages with four radial axles as used on the London and North Western Railway in 1882. These latter coaches were carried on eight wheels, the two middle pairs were fixed, the two end pairs being free to move sideways in a radial direction when passing over a curve. However, on most British railways, the standard carriages of the later eighties were still six-wheelers about 30 feet long and 8 feet wide ; and although they adhered to the flat roof design, an inside height of 7 feet was normal and with increasing comfort the tare weight per seat was steadily rising. Many of these six-wheelers are still in existence, and weigh about 13 tons, seating fifty third- or thirty-two first-class passengers. The Great Northern had adopted this type of carriage in 1876, and it remained as their standard for many years. This line was early in adopting the simple vacuum brake, and by the beginning of the eighties nearly all its passenger carriages had been so equipped.

All-steel bogies were adopted by the London and North Western in 1892. The same railway had employed drawing-room cars since 1882, and put into service a corridor train in 1893 on the 2 p.m. service to Scotland ; for many years this train was known as " The Corridor." The rival East Coast route did not employ corridor expresses until 1896. In 1893 the Great Western put into service its first dining car, an inauguration which closely

followed the adoption of the corridor train. Though much has been written about the great increase of tare weight to be hauled through the use of corridor carriages and dining cars, which necessarily reduce the seating capacity of any train, it should be remembered that there are many offsetting advantages from an operating point of view as well as from the increase in comfort and betterment in service obtained by the passenger. The corridor train permitted the collection of tickets on the train, the dining car the elimination of stops for meals at such stations as Crewe, Rugby, and York, and the quickening of overall speed thus obtained contributed considerably to increasing the capacity of many of the British main lines. The example was followed by the Great Northern Railway, which put into service third-class dining cars running on twelve wheels in 1896, and these clerestory roofed vehicles weighed no less than 38 tons and only seated forty-two persons.

At the end of the century great improvements were being effected in the lighting of passenger carriages. Previous to the eighties lighting had been furnished by oil only. At the commencement of that decade one line at least was using shale oil gas. Later with the coming of the incandescent gas mantle the power of the lamp, which had been about sixteen candles, was greatly increased. The London and North Western Railway adopted the Stone system of electric lighting in 1895. Some time earlier, it is true, experiments had been made with a lighting system from a dynamo mounted on the locomotive tender; this, however, did not prove successful. Even the best coaching stock of the London and North Western in 1891 consisted of carriages, 42 feet long, lighted by oil gas and heated with foot warmers. For many years the foot warmer was the main form of carriage heating; it consisted of a flat closed tank filled with chemicals which generated heat as a result of immersion in boiling water, the chemicals storing up the heat which resulted from the crystallization of the solution as the water cooled. Early in the twentieth century steam heating became standard, the steam being derived from the locomotive;

but in slip carriages the foot warmer held universal sway until 1908, when the Great Western designed an adaptor, by means of which steam heating from the locomotive could be supplied to the slip carriage.

Of recent years the London and North Western, the Midland, and the Great Eastern Railways have been famous for their excellent dining-car services. In the latter case they date back to the early nineties when some six-wheelers were fitted with end gangways and served as dining cars for third-class travellers. On opening their new route to London the Great Central Railway in 1898–1899 offered dining-car service to its patrons, and stimulated its competitors to adopt corridor expresses ; while for the summer services of 1901 the London and South Western Railway added dining-car service to their West of England trains.

The Great Western has been a strong believer in long carriage bodies as a means of reducing the dead weight per seat of its carriages, a policy only made possible by the fact that its original wide gauge gave it a greater width between the up and down lines over much of its mileage, which allows a maximum width of 9 feet 6 inches for carriages. Thus by 1902 the 58-foot standard of the nineties had given place to third-class carriages 68 feet long, which contained ten compartments, giving one hundred seats on a tare of hardly 30 tons. Three years later corridor carriages 2 feet longer were being built, seating eighty on a tare weight of 33½ tons. From 1902 all Great Western passenger carriages have been constructed with the semi-elliptical roof which gives a greater air space and is cheaper to build and maintain than the older clerestory type. The Great Western was not, however, the only line to adopt the semi-elliptical roof, for in 1906 this type of roof with electric lighting was adopted as standard for the Great Eastern Railway, and numerous 50-foot corridor vehicles of this type were put into service. Nearly 9 feet wide and containing seven third-class compartments, these carriages set a high standard at a comparatively early date. In 1905 the Great Northern Railway had also adopted the elliptical

roof as standard, in conjunction with steel underframes and electric lighting.

At about this date first-class compartments were being allowed a width of 7 feet and third-class compartments a width of 6 feet ; these figures still hold good to-day.

In 1908 the Great Western gave up, in favour of dark lake, its famous chocolate and cream livery, which it had adopted in 1856, before which first-class coaches had been painted yellow, second-class brown, and third-class green. Amongst early British lines to adopt this painting system was the Sheffield and Rotherham in the late thirties. Fifteen years later on the Great Western reversion was made to the original cream and chocolate colours, as it was considered that the famous colours acted as an important canvasser of passenger traffic, whilst it is noteworthy that the lighter colours, though more expensive to commence with, are better looked after by the staff, and are therefore not more expensive if all the advantages are taken into consideration. During 1927 the Great Western scheme of painting has been still further simplified. It is worthy of note that even in the United States, where first cost and maintenance are regarded as the main considerations, such a famous line as the Chicago North Western still retains the distinctive bright yellow for its passenger cars, and other railways are returning to more attractive colours than dull green for the passenger cars on the best trains.

No account, however short, of the passenger carriage development at this period would be complete without mention of the celebrated Port Carlisle Dandy, which, drawn by a horse, ran on the Port Carlisle branch of the North British Railway until shortly before the war. Lighted by a single oil lamp, this little wooden box for first-and second-class passengers, with windows on all four sides, racks for luggage on the roof and outside longitudinal seats at the sides for third-class passengers, is one of the most interesting railway relics ; appropriately it bore the number 1 on the North British Railway. So successful was this Dandy that the North British in 1910 put into service a second, which, though younger than

its sister, was typical of the three-compartment carriages in use in the Mid-Victorian period. This famous Dandy has now received an honoured resting-place in Waverley Station, Edinburgh.

It is a matter for surprise that the British railway practice adhered to gas lighting for passenger carriages. As late as 1913, both the North British and the Highland Railways built gas-lighted coaches for their main line services, and these were probably not the most recent cases. From present indications it would appear that Great Britain will be the last important country to possess gas-lighted carriages running on its main expresses. Germany and France are rapidly converting to electric lighting, and in Switzerland gas-filled coaches have not been permitted to run since 1924. In Great Britain comparatively little conversion has been attempted in recent years, although the Midland converted over 800 coaches and the London and North Western large numbers. Much honour is also due to the London, Brighton, and South Coast, which fitted many carriages with electric light during the last decade of the nineteenth century, and to the London and South Western Railway, which adopted electric light as standard in 1902. In 1914 the Great Northern of Ireland had 96½ per cent. of its carriages electrically lighted, the South-Eastern and Chatham Railway being second with 61·7 per cent. Gas lighting is less expensive to instal and maintain, hence its continued use.

As a result of the Hawes Junction and Aisgill accidents on the Midland considerable attention was directed to the question of electric lighting, which was strongly advocated by the Board of Trade inspecting officers, and in 1914 the Lancashire and Yorkshire Railway, when building a gas-lighted train, adopted many anti-fire devices, such as steel panels and underframes, automatic valves for the gas reservoirs, and emergency windows; but as long as wooden carriages and coal fires in locomotives exist, so long will risks arise due to débris and hot ashes. After the Jarrow accident on the North Eastern Railway in December, 1915, attention was again

drawn to the danger of gas lighting of railway carriages. Electric lighting had then been standard on the North Eastern for three years, but on December 31st of that year, only 626 out of 4,867 carriages were so lighted. To the North Staffordshire and the London, Tilbury, and Southend Railways belongs the credit of being the first British railways to have all their carriages electrically lighted, and, curiously enough, the former was the only one for many years to place its carriage lighting under the care of its electrical department.

In 1914 the Midland Railway finally decided on the elliptical roof as opposed to the clerestory, which had been the feature of their carriages for so many years, but none of this design were actually put into main line service until 1917. These corridor carriages, which were fitted with steel ends and electrically lighted, were 54 feet long, 9 feet wide, and seated sixty-four third-class passengers on a tare weight of 29 tons. In 1918 the Furness Railway gave up the white upper panels on its passenger carriages, while five years later the famous London and North Western colours, as a result of grouping, gave place to Midland red except for the Royal train and a few special cars, and lost thereby, not only a link with the coaching practice of the early nineteenth century, but a method of advertising second to none in effectiveness. The Great Eastern in 1920 changed its allegiance from varnished teak to crimson lake, but, as a result of grouping, has returned to varnished teak as a constituent part of the London and North Eastern Railway.

As was pointed out in a paper read before the Institute of Civil Engineers in 1918,[1] the railways of Great Britain retained timber framework for their carriages long after American practice had standardized on metal construction. Out of 52,250 passenger carriages in Great Britain, maintained the author, nearly all had timber structures, while in the United States 17,601 steel passenger cars were in existence. In this respect one should add that

[1] "All-Steel Passenger Cars," by Mr. F. E. Gobey, Assistant Carriage and Wagon Superintendent, Lancashire and Yorkshire Railway.

American preference for steel cars was largely due to safety considerations and pressure from the Interstate Commerce Commission, the greater degree of safety in Great Britain being attained by a proportionately larger capital expenditure per mile on signalling; in other words, a policy of prevention being considered better than one of cure. Nevertheless, it is, perhaps, unfortunate, in view of the trade depression which has continued since 1920, that those responsible for passenger carriage design should not have favoured to a greater extent a material which can be cheaply and efficiently made by an industry within the country, rather than relying upon raw material which must necessarily have been imported to a very large extent, though mainly from within the Empire, thereby tending to increase our unfavourable balance of visible imports and exports. There can be little question that steel carriages do give added protection in case of accident, though the use of steel adds certain difficulties, such as increase of noise, unless properly insulated, and greater expense of repair when damaged. Its use is, however, extending very rapidly on Continental and other railways, and the experience derived from the supplying of steel carriages to British railways would have aided considerably carriage-building firms competing for tenders from railways abroad. The question of first cost is, nevertheless, very important.

The year 1921 saw an important development in British carriage design when Mr. Gresley put into service on the Great Northern Railway a quintuple dining-car set for service between King's Cross and Leeds. Some years before he had experimented with some suburban carriages by mounting three carriage bodies on four four-wheeled bogies, thus saving a considerable amount of dead weight and reducing the oscillation invariably felt in the end compartments of any carriage. The new dining-car sets of five carriages are mounted on six four-wheeled bogies, thus making a rigid train. The main disadvantage of this system is that if any repairs have to be done to one coach-body, bogie wheel, or axle, the whole articulated

set must temporarily be put out of use, but this disadvantage has not been in practice very serious, and besides numerous examples of this system on the London and North Eastern Railway, the Great Western has recently adopted it for certain trains carrying set formations. Abroad, the New York subways alone have adopted the system to any extent, though isolated cases are in existence, such as those on the Paris-à-Orleans Railway of France, and the special twin saloon used by the Prince of Wales on the South African Railways. The quintuple dining set for the Leeds to London service was also noteworthy in that all the cooking was done by electricity.

In 1921 what are probably destined to be the last four-wheeled passenger carriages for use on the four great railways of England were built for the Edinburgh suburban work on the Balerno branch. These set trains of eight four-wheelers, electrically lighted, weigh only 111 tons empty, and were especially designed to travel easily over the sharply graded and curving Balerno branch; they are probably the most comfortable four-wheelers on any British railway. With these may be compared the new five-coach bogie sets recently built by the London, Midland, and Scottish for the Cathcart Circle line at Glasgow, with steel panelled bodies and steel underframes. Each set accommodates 160 first-class and 264 third-class passengers. The only other important order for four-wheelers during the present century was the construction of some trains for the North London Railway in 1911. This adherence to an old fashion was a matter of much surprise at the time.

A further step in British carriage design was made on the Great Western Railway in 1923, when certain seven-coach set trains with bow-shaped ends equipped with automatic buckeye couplings were put into service, although for many years centre couplings had been employed on East Coast expresses. These steel-panelled corridor trains were also fitted with drop-down side buffers so that they could be coupled to other carriages of ordinary design, while exteriorly they present a flat

surface to facilitate cleaning, a point which in view of rising wage rates has been often given too little attention. They also present fewer places for corrosion. During 1925 the articulated system already mentioned was further extended; firstly, in the form of the ten-coach suburban set trains for the London and North Eastern Railway. These trains seat 872 persons, and are in reality two quintuple sets of five coaches each, each set being mounted on six four-wheeled bogies. In between the crush or peak periods they can be cut down to half, and strengthened with their sister sets for the business rush hours. The saving in length due to the articulated system is an important consideration in suburban traffic, where often platforms are short and maximum seating capacity must be obtained in minimum length and with a minimum tare, or dead, weight. That this problem is no new one is clear when one considers the close coupled bogie trains built by the South Eastern Railway in the early eighties. Later in the same year, 1925, the Great Western adopted the articulated system for certain of its long-distance corridor trains, where set trains which can be strengthened on special occasions could be used to advantage.

Early in 1926 the L.M.S.R. put into service 250 all-steel passenger carriages for main-line working; if proving successful and later adopted as standard for the biggest British line, this departure will be looked back upon as an important landmark in British railway carriage design. When compared with Continental first- and second-class compartment vehicles, British carriages of the twentieth century have been consistently lighter in weight per seat. It is impossible to compare third-class carriages, as Continental ones are not upholstered, and do not offer the same degree of comfort. German main-line carriages often total over 40 tons and sleeping cars 50 tons, though some Great Western sleeping cars, 70 feet in length, built in 1907, mounted on six-wheel bogies, weighed 41 tons. The latest steel standard corridor carriages in France weigh about 43 tons, and seat seventy-two third-class passengers in nine compartments. Compare with this a

modern British railway's nine-compartment corridor third, seating the same number of passengers but only weighing about 32 tons or even less, or again a third-class non-corridor carriage, nearly 70 feet long, seating six a side in eleven compartments, which gives 132 seats on a tare weight of about 30 tons. Similarly the latest L.M.S.R. all-steel centre corridor carriage seats fifty-six third-class passengers, on a tare weight of 29 tons. Recently the L.N.E.R. have placed orders for some all-steel luggage and brake carriages and the L.M.S. already have 100 of these vehicles.

To summarize, it will be clear that increasing length until a standard of nearly 60 feet was reached is, perhaps, the main characteristic of carriage evolution. Hand in hand with it went increased interior height, thus causing the change from the flat roof to the clerestory and later to the semi-elliptical. For lighting there has been a change from oil to coal gas, oil gas, then the fitting of incandescent gas mantles, and finally electric light. The last is now standard, being generated by dynamos driven from the axle of the carriage and provided with storage batteries. Spring buffing has improved steadily in design from the Early-Victorian era. Steam heating has been mentioned earlier in this chapter, and also emergency braking by a passenger, a system only made possible by the adoption of the automatic brake, made compulsory by the Regulation of the Railways Act of 1889.

As regards wheels, the present steel disc wheels have superseded the Mansell type of wheel built up of wooden segments, which in turn succeeded the cast-iron wheels of the forties. British railways appear to have definitely discarded the twelve-wheel (six-wheel bogie) design for passenger carriages, although it was fairly common for dining, sleeping, and Pullman cars at certain periods; while the East Coast Route possessed many corridor compartment carriages fitted with six axles. With carriages of over 65 feet in length, however, six-wheel bogies must usually be employed, as otherwise the length between the axles would necessitate a greatly increased length of point locking bars and other safety equipment.

Apparently it has been decided that the extra weight which this design involves does not result in proportionately smoother riding, and with the articulated car system now favoured by at least one line it is doubtful if the twelve-wheeler will ever come into its own again, except for the longest and most luxurious class of sleeping, dining, and Pullman cars. Even in the United States, where passenger-car tare weights, owing to steel construction, are high, the four-wheel bogie has recently been reverted to in many cases.

It is much cheaper to build straight-sided vehicles with semi-elliptical roofs, but this design could not become standard to most railways owing to loading restrictions; consequently to obtain maximum width at seat level the boat-shaped side was adopted, thus allowing clearance of the stepboard and platforms. The practice of carrying the window right up to the eaves, to-day only adopted as standard on the L.N.E.R., while giving greater light, should not, if well designed, reduce the body strength or materially increase the cost of construction. The later designs of British carriages are world renowned for their comfort, and it is doubtful if the side corridor, well beloved by the Britisher noted for his reserve, will ever be superseded by the open centre corridor, experimented with at various periods.

The main problem facing the carriage designer is to retain strength of construction, and retain or even increase the degree of comfort, whilst at the same time reducing the unladen weight per seat. In addition the problems of first cost and maintenance charges have to be taken into consideration. It is doubtful if any country can offer more comfortable accommodation for the lowest class of passenger than is offered him by the British railways of the present day.

Nearly all criticism directed against the passenger rolling stock of the British railways in recent months has been concerned with the lack of third-class sleeping cars, and it would seem that in the near future the popular demand for a few such carriages will have to be met. Such vehicles are only required for long-distance services

like those between London and Scotland or Penzance and for journeys taking six hours or over ; the mileage per month to be obtained from such services would not be lower than that of the day trains, such as the " Scotsman " or the " Royal Scot," which only make one round journey per forty-eight hours. The American type of sleeper might be adapted for these services with ease, possessing a seating and berth capacity for thirty-two. With a supplementary fare of 10*s*. such carriages would supply a definite want.

The following table shows at a glance the seating capacity and tare weights of typical rolling stock at home and abroad :—

TABLE IX.—Rolling Stock

BRITISH RAILWAYS

Railway.	Seating Capacity.	Class.	Tare Weight.	Type.	Remarks.
			Tons.		
L.M.S. (Caledonian)	50	3rd	13	4-wheeler	Non-corridor
S.R. (L.B.S.C.R.) .	50	3rd	11	4- ,,	,,
S.R. (L.B.S.C.R.) .	32	1st	13	6- ,,	,,
L.M.S. (Caledonian)	60	3rd	15	6- ,,	,,
L.M.S. (L.N.W.R.).	50	3rd	13	6- ,,	,,
L.N.E. (G.N.R.) .	50	3rd	15	6- ,,	,,
L.N.E. (G.E.R.) .	60	3rd	17	6- ,,	,,
L.N.E. (N.B.R.) .	50	3rd	15	6- ,,	,,
G.W.R.	100	3rd	30	8- ,, bogie	,,
L.M.S. (L.N.W.R.).	64	3rd	30	8- ,, ,,	,,
L.M.S.R. (Standard)	108	3rd	27	8- ,, ,,	,,
L.N.E. (G.E.R.) .	56	3rd	31	8- ,, ,,	Corridor
G.W.R.	64	3rd	30	8- ,, ,,	,,
L.M.S. (Caledonian)	72	3rd	36	8- ,, ,,	,,
L.M.S.R. . . .	56	3rd	29	8- ,, ,,	Centre corridor. (All steel.)
S.R.	56	3rd	30	8- ,, ,,	Corridor
Pullman. . . .	36	3rd*	37	8- ,, ,,	Centre corridor
Pullman. . . .	20	1st*	32	8- ,, ,,	,, ,,
Pullman. . . .	24	1st*	42	12- ,, ,,	,, ,,
L.N.E. (G.N.R.) .	20	1st*	60	12- ,, ,,	Sleeper

* Extra charge made for use of these cars, which vary greatly in seating capacity per ton.

TABLE IX (*cont.*).—CONTINENTAL RAILWAYS

Railway.	Seating Capacity.	Class.[1]	Tare Weight.[2]	Type.	Remarks.
			Tons.		
Nord	40	3rd	7	4-wheel	Non-corridor
Nord	24	1st	7	4- ,,	,,
Nord	32	2nd	7	4- ,,	,,
Swiss Federal	45	3rd	9	4- ,,	Corridor
Swiss Federal	60	3rd	18	4- ,,	,,
French State	80	3rd	15	4- ,,	,,
German Railway	56	4th	17	6- ,,	,,
Swiss Federal	62	3rd	22	6- ,,	,, (1918)
Belge National	36	2nd	26	6- ,,	,,
Belge National	125	3rd	50	8- ,, bogie	,,
Est	100	3rd	25	8- ,, ,,	Non-corridor
Est	56	1st	30	8- ,, ,,	,,
Loetschberg	72	3rd	36	8- ,, ,,	Corridor
Swiss Federal	80	3rd	34	8- ,, ,,	,,
Swiss Federal	80	3rd	17	8- ,, ,,	,,
German Railway	64–68	3rd	35–41	8- ,, ,,	,,
Pullman sleeper	15	1st*	51	8- ,, ,,	Rome Express.
Pullman day car	24–30	1st*	47–51	8- ,, ,,	Golden Arrow, 77 ft. long
Mitropa sleeper	20	1st*	53	8- ,, ,,	Corridor

AMERICAN AND CANADIAN RAILWAYS

Railway.	Seating Capacity.	Tare Weight.[3]	Type.
		Tons.	
Chicago and North Western all metal	98	49	8-wheel bogie[4]
Boston and Albany steel day coach	100	50	8- ,, ,,
Typical day coach	80–100	48	8 or 12-wheel bogie
Typical all steel sleeper	32	75	12- ,, ,,
Typical parlor car	40	72	12- ,, ,,
All steel Pullman chair car	40	84	12- ,, ,,
All steel Pullman sleeper	32	95	12- ,, ,,
C.P.R. day coach	80	65	8- ,, ,,
C.P.R. parlor car	40	50	8- ,, ,,
C.N.R. steel diner	32	85	12- ,, ,,
C.N.R. steel sleeper	32	80	12- ,, ,,
C.N.R. steel day coach	80	80	12- ,, ,,

* Extra charge made for use of these cars, which vary greatly in seating capacity per ton.

[1] No continental third or fourth class accommodation is upholstered.

[2] Continental tons are metric tons = 2,204 lb.

[3] All United States and Canadian tons are short tons = 2,000 lb.

[4] These cars are fitted with roller bearings.

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CHAPTER X

WAGON DESIGN

The development of wagons in Great Britain can be dealt with more shortly. Owing to the fact that many of the early railways were built for the carriage of coal or some other mineral, it is not improper to look to the old chauldron wagons as the original ancestor of the British standard freight and mineral wagons. This chauldron type of wagon is still in use in the Tyneside and Durham coal-fields on Coal Companies' private lines, though it has long been out of use on passenger-carrying railways.

As with the passenger-carrying vehicle the objective which the wagon-designer has been aiming at through a hundred years of railway development has been the increase of carrying capacity both in volume and weight as compared to the weight of the wagon when empty. The haulage of the wagon itself, though necessary as a container to convey the goods, is a dead loss so far as haulage is concerned, and consequently results each year in a serious economic loss, which not only affects the shareholders of the railway, but eventually acts as a tax upon the nation's power of production. The early chauldron wagons as used on the Stockton and Darlington Railway carried 4 tons of coal on a tare weight of $2\frac{3}{4}$.

On the Liverpool and Manchester Railway double-decked sheep wagons were in use, and even to-day are still used on the Highland section of the London, Midland, and Scottish Railway; but as a general practice this type of wagon has never met with universal popularity, since it involves expensive ramps for loading, and makes the wagons useless for cattle or horse traffic. The early wagons for general traffic were about 9 feet long, and ran,

as do nearly all British and Continental wagons of to-day, on four wheels. The great majority of wagons were what would be now described as flats, or one-plank wagons, usually constructed of wood, as were the frames. The wheels and axles were of iron. In the fifties the ordinary wagons were about 11 feet long and carried 6 tons. On the broad-gauge Great Western the wagons were rather longer, and in some cases measured 20 feet. This line as early as 1879 adopted a metal frame, and in 1902 adopted sheet supporters for its open wagons whose sides had gradually grown from 11 inches to 2 ft. 11 in.

The developments in wagon design during the nineteenth century were a gradual increase in size, the provision of many types of wagons for the various kinds of traffic to be handled, and improvements in drawbar design. At the end of the century the average capacity for open wagons had reached 8 tons, and for covered wagons about 6 tons. The rate of growth of size had thus been very slow, but there were adequate reasons for this, mainly consisting in the retail nature of British trade, and the fact that most bulk traffic was handled in wagons owned by traders whose main object was to avoid expensive first cost of construction or alteration of colliery screens, and who were not interested in the effect of their policy upon the operating problems which the railways had to solve. Nevertheless one Scottish railway had put into service as early as the sixties 30-ton wagons.

This feature of British railway practice, which was a remnant of the outlook with which railways were regarded before the advent of Queen Victoria to the throne, has had severe effects upon the industrial prosperity of the country, and it is a problem which still awaits solution. It will be dealt with more fully in a later chapter of this book, but it may be noted here that it arose from the fact that each of the traders was expected to employ his own rolling stock and motive power as he would have done on the roads. Although from the first the motive power, when mechanical, was supplied by the Railway Company, who a few years later invariably supplied the carriages for passengers, yet the trader even to-day, in

many cases, uses his own wagons. A similar policy exists in no other country and would not be tolerated by State-owned and operated systems, which take care that the trader is only permitted to build wagons which the State finds too expensive to construct. The twentieth century has seen very considerable development in British wagon design, although British wagons are still very much smaller than foreign wagons in carrying capacity. The 8-ton open wagon, so popular on many British railways, is a luxury wagon, no doubt admirably suited to the retail nature of the country's internal trade ; but it is an expensive luxury, since it weighs no less than 5 tons at the minimum, and gives little cubic capacity. In spite of this disadvantage, the trader preferred for many years to pay the high freight rate and to retain this carrying unit.

About 1912 the standard wagon became one of 10 tons carrying capacity with wooden frame and sides as previously, and fitted with an oil-box axle in place of the grease-box axle. It is true that a more progressive policy had been adopted at an earlier date by certain railways. Amongst these may be mentioned the Great Western, which had long used metal frames and oil boxes, and fitted their wagons with a special type of brake, capable of being applied from either side of the wagon, and thus facilitating marshalling yard work very considerably. The North Eastern had from the beginning of the century adopted a progressive wagon policy in connection with their coal export trade, by building 20-ton bottom-discharge mineral wagons and 40-ton bogie coal wagons for use on the staiths at Blyth or elsewhere. Twenty-ton wagons were in use for locomotive coal traffic on many lines, notably the Great Eastern and Great Western, where they have been used since 1897 ; but the efficiency of freight train movement is regulated by the efficiency of the weakest link, and one must admit that during the early twentieth century there were usually many weak links on British freight trains, namely dead buffered wagons.

After the war period the Railway Clearing House

standard for open wagons was raised to 12 tons, a wagon capacity which had been in fairly common use for mineral traffic prior to 1914. This new standard included both-sides brakes and oil-box axles, but curiously enough the steel frame was only at that time included as an alternative, wood being generally preferred until the last year or two both by certain of the railways and by private owners.

In 1911 an Order was issued under the Railway Employment (Prevention of Accidents) Act of 1900 forcing all wagon-owners to fit brake levers on both sides of the wagon ; in spite of this order there are still many wagons running with brake levers on only one side owing to delays caused by the war.

A type of wagon which has prospered in Great Britain is the bolster, or its enlarged brother the double bolster. A difficult wagon to load safely, it is rapidly being replaced by bogie wagons on Continental railways, and in time it is bound to give way to the bogie wagon in our stronghold of four-wheeled wagons ; already the G.W. and L.M.S.R. have large numbers of bogie wagons built during the last ten years.

A typical traffic which has been found eminently suitable for high-capacity bogie wagons was the L.N.E.R. brick traffic from the Peterborough district, for which the Great Northern built special 50-ton wagons in 1921 ; these wagons have the low tare weight of under 17 tons.

Although eight-wheel bogie wagons for coal and mineral traffic have from time to time been given trials on British railways, notably the North Eastern, and although some Great Western 30-ton bogie rail wagons were built as long ago as 1890, it cannot be said that any of the designs for minerals met with conspicuous success. The causes for this are somewhat difficult to analyse, but amongst the most important may be mentioned three. The first is, undoubtedly, the fact that, in Great Britain, it is extremely difficult to keep a large bogie wagon in regular employment. Bulk shipments, except in the case of certain special traffics, like export coal, are rare. Secondly, great variation in size between wagons on the

same train is apt to cause considerable difficulties at marshalling yards, where maybe a hump is so designed and graded as to be suited to an average gross wagon weight of 15 tons. Similarly, the long bogie wagon for general merchandise is not suited to many British freight stations, where small turntables are common, and, in the case of many curved sidings, its overhang may be so great as not to permit it to take the curve. For these reasons the bogie wagon, except for special loads where it is essential, was not popular with British railwaymen; they considered that a wagon, to be a good dividend-earner, must be able to circulate on practically all sidings. One should also bear in mind that the small type of bogie wagon with a carrying capacity of 30 tons shows no advantage over the 15- and 20-tonner, so far as carrying capacity to tare weight is concerned. The following table, giving typical but not necessarily the most modern designs, will demonstrate this point:—

TABLE X.—Wagon Types

Type.	Capacity.	Tare Weight. (In round figures.)	Remarks.
	Open Wagons		
	Tons.	Tons.	
Chauldron	4	2¾	Wooden.
L.M.S. (L.N.W.R. design)	6	5	Reinforced wood frame.
L.M.S. (G.S.W.R. design)	10	7	Wood frame.
G.W. (freight)	10	5¾	Open high sides.
L.M.S. (L.N.W.R. design)	10	6½	Reinforced wood frame.
S.R. (L.S.W.R. design)	12	7	Steel underframe.
S.R. (L.S.W.R. design)	12	7½	Wood underframe.
Typical privately owned	12	7	End door, wood frame.
S.R.	12	6¾	Metal underframe. Coal wagon, side door.
Nord (France)	15	8	Wood frame.
L.M.S. (G.S.W.R. boiler)	16	8¼	
L.M.S. (Caledonian design)	16	6¼	End door, steel underframe.
L.M.S. (Caledonian design)	16	7½	End door, wood underframe.
L.M.S. (G.S.W. mineral)	20	9¾	
G.W. (mineral)	20	9¾	Bottom doors.
L.M.S. (Caledonian)	30	13¾	Bogie, hopper doors.
Est (France)	30	15	,, ,, ,,
L.N.E. (mineral)	40	18½	Side and end doors.

TABLE X (*cont.*).

Type.	Capacity.	Tare Weight. (In round figures.)	Remarks.
		OPEN WAGONS	
	Tons.	Tons.	
Bengal Nagpur (mineral)	42	22	Bogie, hopper doors.
L.M.S. (Furness design)	45	12¾	Bogie wagon for ore traffic.
L.N.E. (G.N. design)	50	17	For brick traffic.
[1] Typical U.S. mineral (L.V.R.R.)	50	21	Bogie, all steel, hopper doors.
[1] Typical U.S. mineral	50	18	,, ,, ,,
[1] Pennsylvania (mineral)	50	23	,, ,, ,,
L.N.E. (mineral)	60	31¼	Bogie, hopper doors.
[2] German Railway	60	19	Metal, 8-wheel saddle wagon, self-discharging.
[1] Virginian (U.S. mineral)	100	35	Bogie, all steel, hopper doors.
[1] Norfolk & Western (U.S. mineral)	100	27¼	,, ,, ,,
[1] Virginian (U.S. mineral)	120	35¾	Bogie, all steel, gondola [type.
		COVERED WAGONS	
G.W. (box)	10	6¾	Steel frame.
Nord (France)	10	8	,, ,,
Swiss Federal	12	8	,, ,,
Swiss Federal	15	10	Steel frame, brake box.
[1] C.P.R.	27	17	Bogie, wood underframe.
[1] Typical U.S.	30	18¾	,, ,, ,,
L.N.E. (G.N. design)	30	16¾	Bogie, fitted vacuum brake.
L.M.S. (L.Y. design)	30	14¾	Steel frame.
Est (France)	30	15½	Bogie, steel frame.
[1] Typical U.S.	40	17	Bogie, steel underframe.
[1] C.P.R.	47	19	,, ,, ,,
[1] C.N.R.	60	24	,, ,, ,,
[1] G.N.R. (U.S.)	75	30	,, ,, ,,
		FLAT WAGONS	
Swiss Federal	10	5	
Swiss Federal	15½	9	Steel frame.
Swiss Federal	18	14	Bogie, brake box.
G.W. (Macaw E.)	30	19½	,,
Nord (France)	30	15	,,
[1] U.S. Typical	30	12	,, steel underframe.
Swiss Federal (special)	36	25	,, all steel for electrical machinery.
L.N.E.R.	40	19½	,,
G.W. (Macaw D.)	40	23	,,
[1] U.S. Typical	40	15	,, steel underframe.
L.M.S. standard	40	20 (without baulks)	Bogie, well wagon.
G.W. (Crocodile J.)	50	28	,,
L.M.S. standard	80	45 (without baulks)	Double bogie, well wagon.

[1] Short or U.S. ton. Westinghouse fitted. [2] Fitted with Kunz Knorr brake.

In 1926 a committee of the American Railway Association recommended a ratio of tare weight to carrying capacity of 1 : 3 ; and a tare weight of approximately 25 tons for the 70-ton hopper wagon designed by a sub-committee on self-clearing hopper wagons. It should be noted that the principal cause of this type of wagon's deterioration is corrosion from their use in coal service.

Directly one passes the 40-ton size one begins to obtain a better ratio, as witnessed by the 100-ton coal car of the Virginian Railroad in the United States. While the 40-tonner shows little superiority over the 20-tonner in relation to tare weight to capacity, it does show considerable superiority in the matter of space occupied, and thereby enables sidings to handle considerably increased tonnage. It enables marshalling yards reception sidings to perform greater work with very little additional capital expenditure and reduces the resistance for freight trains as compared with a train of lower capacity four-wheeled wagons carrying the same tonnage.

During the last two years the Great Western has attempted to introduce 20-ton wagons as the standard for the coal export trade of South Wales, and has over a thousand in use. As an inducement to the coal-owning interests to adopt this type of wagon a reduction of rate of 5 per cent. is offered, it being recognized that the trading interests should share in the results of the increased operating efficiency, since in certain cases capital expenditure might be required to adapt mine screens and lines to take the larger type of wagon. The alleged increased breakage of coal through the use of a 20-ton wagon is probably exaggerated, as no similar difficulty is experienced abroad, but this may be due to the quality of the coal.

The following figures given in a paper before the Institute of Transport in 1926 [1] show the advantage to be gained by the adoption of a higher-capacity wagon where practical. To carry a load of 600 tons of coal in

[1] "Recent Developments in the Shipment of Coal at South Wales Ports," by John Auld, M.I.Mech.E., read before the Institute of Transport, January 4th, 1926.

10-ton wagons, a tare weight of 369 tons must be used, which makes a gross or total weight of 969 tons; with 12-ton wagons, the tare weight is 350 tons, making a gross tonnage of 950 tons; but with 20-ton wagons, the tare weight falls to 288 tons, and the gross tonnage is, therefore, only 888 tons. The 20-ton wagons used in this calculation were of the new Great Western mineral design, and are provided with end doors as well as side doors. Their wheel base is 12 feet as compared with 9 feet of the 12-ton wagon. Considerable difference of opinion exists as to the employment of steel for the sides, ends, and floors of coal wagons. On the Continent it is claimed that the coal does not cause serious damage through rust to such wagons, but with British coal difficulties are said to arise through this cause.

With the special nature of British trade it is doubtful if the railways in their present form will ever find it economical to adopt a larger standard wagon than a 20-tonner. At the present time it is questionable if the 15-tonner even would be suited to trade requirements, for length of haul, weight of the average consignment, relation of cubic capacity to weight, and water, air, and road competition affect the situation vitally. In any case, it will be many years before the present stock of 8-ton and 10-ton wagons has entirely disappeared, and they will only gradually be replaced by those carrying 12 and 15 tons.

Although this is not the appropriate place to deal with the many various types of wagons for special traffics, it is worthy of note that an industrial country must have at its disposal, whether owned by traders or by the Railway Companies, wagons of many special types in addition to the three standard types of wagons, namely, the covered, high-sided open, and flat wagons. Amongst the special varieties of covered wagons, one may find banana vans, refrigerated vans, many of which are fitted with automatic brakes for fast train service, motor-car vans, fish, fruit, and vegetable vans, and cattle wagons. The open high-sided type may be divided into the standard goods wagon and the mineral with either end, side, or

bottom doors, or a combination of these. Amongst low-siders and flats one finds well wagons, bolster wagons, timber wagons, boiler and plate wagons.

Two opposing tendencies are at once evident: namely, the needs of trade and industry, which necessitate special wagons for various classes of traffic, and the desire of the railway operating officer, who, to obtain maximum efficiency, endeavours to reduce his standard types to the minimum in number so as to avoid empty running, extensive shunting, and to minimize the difficulties of distribution. The main problem is to find the happy mean between these points of view, a task which is by no means an easy one.

In brief, the main features of present wagon design in Great Britain are a wooden-sided wagon on a steel frame with oil-box axles, side doors, and a carrying capacity varying from 12 tons for general merchandise to 20 tons for mineral work. For special loads, steel wagons mounted on bogies to distribute weight are essential and will probably achieve greater popularity in future years.

Table XI, showing the comparative length of haul, average revenue load carried, and average wagon or car capacity in Great Britain and certain foreign countries, will partially explain the reason why a smaller-sized wagon is in use in this country; but one should add that in every country, when it has been proposed to adopt a higher-capacity wagon, opposition has been very pronounced, and it is doubtful whether the average revenue load per wagon is not to some extent caused by the small cubic capacity of the average wagon in circulation.

It is sometimes suggested that even if high-capacity wagons are constructed, through the small amount of traffic offered they will not necessarily be as well employed as a smaller wagon. The following set of figures[1] (Table XII) seems to show that there is a definite correlation between the size of the average car of each type suitable for loading with specific commodities owned by each railroad and the average load of that commodity actually loaded.

[1] Proceedings of the 19th Regular Meeting of the Trans-Missouri-Kansas Shippers' Advisory Board, September, 1927.

TABLE XI.—Relation between Average Hauls and Load and Capacity of Wagon

	Average Length of Haul in Miles.	Average Wagon Load in Tons.	Average Wagon Capacity in Tons.
Great Britain, 1925	54	5·5	10·5
Germany, 1925	93	7·6	15·9
United States, 1925	169 (per individual railway) 308 (U.S. as a system)	27·0 *	45·0 *

* Short tons.

TABLE XII.—Relation between Size of Car and Average Load

Road.	Tons per Car, 1926.	Coal Cars.
Bituminous Coal		
St. L.S.F.	47·3 *	48·8
Mo. Pac.	46·2	45·1
M.K.T. Lines	46·1 *	45·4
L.R. & N. Co.	45·9 *	37·8
K.C.S.	45·5 *	41·5
St. L.S.W.	45·1 *	46·7
St. P. in T. & L.	44·5	49·3
C.R.I. & P.	44·0	45·6
U.P. system	42·4	49·2
Texas & Pacific	42·1 *	39·9
A.T. & S.F. Systems	41·5 *	45·6
I.G.N.	34·6	37·6
Salt		Box Cars.
U.P. System	36·3 *	49·6
St. L.S.F.	32·9 *	39·0
Mo. Pac.	32·5 *	36·4
A.T. & S.F. Systems	29·5	37·7
C.R.I. & P.	28·3 *	38·8
M.K.T. Lines	25·1 *	33·0
Texas & Pacific	24·5 *	37·7

* Indicates highest average tons per car for the four years 1923 to 1926 or latest year when same average prevailed for more than one year.

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CHAPTER XI

GROWTH OF GOVERNMENT REGULATION
1830–1900

To compress into comparatively few pages the history of the growth of regulation of the railway industry in Great Britain, it is necessary to bear in mind certain fundamental principles which should assist in keeping in right perspective the scale of growth of the regulative principle and the increasing interposition of Parliamentary Acts in railway affairs.

For completeness many regulatory Acts must be duly mentioned, but it is not the Acts themselves which are so important for the reader of to-day to study, or even the effect of their decisions, but rather the gradual change of public opinion of which they are the tangible evidence.

The railway was born in Great Britain, and due largely to this fact and to certain characteristics of the Anglo-Saxon race, there are features of British railway regulation which are unique. The birth of railways came towards the end of that most important period of British history, the Industrial Revolution, perhaps more properly called the Industrial Evolution ; for the opening of the Stockton and Darlington Railway may be regarded as the christening ceremony of the railway child.

Like so many economic movements, differences of opinion may exist as to which was cause and which effect, which was action and which reaction, but coming later than many inventions, the names of which are so closely connected with the Industrial Revolution, it is apparent that railways were the result rather than the cause, in the first instance, of the great series of inventions upon which the wealth of the country was to be based for the coming 150 years. The change-over from domestic

industry to machine industry, the transfer of work from living-rooms to factories, demonstrated the savings to be derived from large-scale industry.

The large output of the factories, a miniature type of large-scale production, could not be absorbed by the home population. Methods of distribution seemed not to have kept pace with methods of production; for an outlet for this surplus, as was seen in a former chapter, the early manufacturers of Manchester and other cities appeared to have looked to the sea. Not necessarily to an overseas market did they look, but to an outlet for their goods to coast towns not served adequately otherwise than by sea transport. In its turn, the arrival of railway facilities stimulated the growth of the factories by lowering the cost per ton per mile of their finished products, thus increasing the area over which their products could compete.

Hence, in Britain, the perfected invention of the railway started its career of conquest at a time when the policy of *laissez-faire* was all-powerful. To freedom of restraint from Government interference was credited the series of inventive processes which at that time were converting England from an agricultural into an industrial country. But what wonder is it that in other countries public opinion was unwilling at first to father this new invention, the railway?

The railway promoters here appear to have made little or no attempt to obtain the financial assistance of the central Government to aid in improving the commercial productivity to compete with continental rivals. Cases occurred fairly often in early railway promotion, where the local authorities assisted considerably in furthering railway construction in their immediate vicinity. Presumably, the early lines were too local in their importance to be able to claim the assistance of the national Government, but what a contrast this makes with the history of certain foreign lines in much more ancient centres of European civilization at much later periods!

No comparison should, or can, be made with countries such as Canada, the United States, or Australia, where by

means of railways large areas of territory were brought under cultivation through immigration, made possible only by an adequate railway system. Such Government aid as was received by the Canadian Pacific, Illinois Central, or Union Pacific systems cannot be compared with anything which ever existed in this country, while thanks to its insular position, military needs did not compel the construction of railways through areas where traffic considerations could never justify such construction. The caprice of ever-changing strategy cannot be called to book for the construction of the few small branch lines which to-day yield less to our railways than the cost of their operation.

A Government regulatory policy should be both fatherly and stern, assisting by rapid assent to urgent measures, yet vigilant to eliminate practices undesirable from the point of view of the community as a whole, or perhaps undesirable from the point of view of the employee. Latterly, however, the boot appears to have made a somewhat rapid transfer to the other leg, the function of a regulatory body being to protect the railway company from the powerful pressure of its own employees.

Though the British lines have never been helped financially by Government aid, before construction could commence, land upon which to build the line had to be obtained and for this purpose the assistance of the Government was essential; "the right of eminent domain" could only be obtained, the Government being willing.

With a national policy of *laissez-faire* still in favour, it will be seen that the growth of regulation started very slowly, and with little momentum, the main object seeming to be to keep the amount of regulative legislation to the absolute minimum. On the other hand, with the canal and road system which England already possessed, and with no localities really far from the sea-coast, the fatherly attitude of the Government was to force railway promoters to prove to it the likelihood of the railway proving financially self-supporting. In other words, it prevented the subscribers to railway promotion from

expending their savings without a reasonable chance of fair return.

During the first three decades of the nineteenth century railways were looked upon in precisely the same light as turnpikes and canals, namely rights of way upon which individuals would run their own vehicles or boats, paying such tolls at toll-houses or locks for their use of the road or canal, as would suffice for keeping the highways and canals in good repair, and leave a margin of profit for the promoters. Hence, the first Act of the legislature which may be said to affect rail transport added the words "tram-ways" and "rail-ways" to the provisions already applying to turnpike roads and canals.

Thus, during the last decade of the eighteenth century, it became necessary for any railway, tramway, or canal promoters to give due notice of any Bills which had as their object the construction of such means of transport.

As early as 1832 an Act was passed which imposed a passenger duty on Railway Companies of a halfpenny per mile for every four passengers carried; in 1842 this passenger duty was abolished and in its place a duty at and after the rate of £5 for £100 upon all sums received for the hire, fare, or conveyance of all such passengers was imposed on railway companies.[1] Three years later, in 1835, the Highways Act, being "An Act to consolidate and amend the laws relating to Highways in that Part of Great Britain called England," [2] required that steam engines be not "erected" within twenty-five yards from any carriage-way or cart-way unless screened from the said carriage-way so that the same may not be dangerous to passengers, horses, and cattle. By Section 71 of the same Act proprietors of railways were required to erect gates where their railways crossed the highways. This serves as a reminder of how densely populated this country was as compared with the newer countries of to-day, for even in 1925 in the United States, the total number

[1] An Act to Repeal the Duties Payable on Stage Carriages and on Passengers conveyed on Railways, etc., August 5th, 1842, 5 & 6 Vict. cap. 79.

[2] *Law of Highways*, by Shelford, 3rd Edition, 1865.

of level crossings was increased by 923, many without gates.

In August, 1839, the Highways Act was amended, some of its provisions being extended to Scotland, and a penalty of £5 was imposed for each day's neglect of the Statute's provisions.[1] This same thorny problem of level crossings was again dealt with by an Act of 1842.[2]

It is interesting to note that as early as 1836 there is mention of the regulation of the rate paid as dividends so long as tolls were at their highest,[3] though this clause appears to have been abolished by the passing of the Companies' Act of 1840.

A Select Committee of 1838 on Railway Communication dealt with the relationship of the railways to the Post Office and completed its deliberations by a report dated March 23rd, 1838, which recommended that the Post Office should be given the power to run engines and trains of its own, and not be liable to toll payments.[4] The Act passed the same year,[5] however, did not adopt this suggestion but merely permitted the Postmaster-General to require any Company to convey the mails on its railway. The safety of the railways at that date is evidenced by the provision of the Act which allowed mails to be sent without a guard. Separate carriages were to be provided and not only mail-bags were to be carried but also mail coaches and carts. Post Office officials were in no wise to interfere with the enginemen and reasonable remuneration was to be given to the Railway Company. Mail carriages were to be resplendent with the Royal Arms.

A further Select Committee was at work during the following two years and issued several reports, but these dealt chiefly with questions of minor interest. It had

[1] Pratt's *Law of Highways*, by Kynnersley, 11th Edition, 1870.

[2] An Act for the better Regulation of Railways and for the conveyance of Troops, July 30th, 1842. 5 & 6 Vict. cap. 55.

[3] The Taff Vale Act of 1836. Section 141.

[4] *English Railways: Their Development and their Relation to the State.* E. Cleveland Stevens. 1915.

[5] An Act to provide for the Conveyance of the Mails by Railways, August 14th, 1838. 1 & 2 Vict. cap. 98.

at last been realized that, unlike a canal, railways were not only toll-collectors, but for purposes of safety must also own carriages, locomotives, wagons, stations, and so forth. The Select Committee's Reports culminated in an Act for regulating Railways, passed in 1840,[1] requiring one month's notice of any new line to be sent to "the Lords of the Committee of her Majesty's privy council appointed for trade and foreign plantations." This Act, requiring the Railway Companies to send returns to the above-mentioned committee relative to rates, fares, accidents, and traffic, was the first general Act authorizing the regulation of railway charges. It also instructed the Board of Trade to appoint the first railway inspecting officers, so that the Board of Trade might be in a position to enforce all Acts of Parliament regulating the railway industry.

The Regulation of Railways Act of 1842 [2] abolished the 4-ton and other restrictions on the capacity and weight of vehicles, which had figured in many of the early enactments, and may be regarded as the first Act referring specifically to the safety of passenger travel by rail. It included amongst other provisions the giving of advance notice to the Board of Trade of the intention to open a railway for passenger train operation, the opening of which might be postponed if the Board of Trade inspection showed the line to be unsafe for travel.

The very important Act of 1844,[3] for which Gladstone was chiefly responsible, in its first section provided that if the profits of any railway amounted to 10 per cent. per annum for three years after the expiration of a period of twenty-one years from the passing of its Act, the Treasury could revise the tolls so as to reduce the divisible

[1] An Act for Regulating Railways, August 10th, 1840, 3 & 4 Vict. cap. 97.

[2] An Act for the Regulation of Railways and for the Conveyance of Troops, July 30th, 1842, 5 & 6 Vict. cap. 55.

[3] An Act to attach certain Conditions to the Construction of Future Railways, authorised or to be authorised by any Act of the present or succeeding sessions of Parliament; and for other purposes in relation to Railways. August 9th, 1844. 7 & 8 Vict. cap. 85.

profits to the level of 10 per cent. There was a counterbalancing condition that any deficiency in the divisible profits required to pay 10 per cent. over a period of twenty-one years be made good by the Government in return. This Act only applied to railways to be constructed after the passing of the Act. It will be observed that this same principle appears in more recent form today in the Railways Act of 1921, and also in the United States Transportation Act of 1920, where a recapture clause exists after 6 per cent. on the value of the property has been earned.

Under the same Act the Government was given power to purchase at the end of twenty-five years, the price being twenty-five times the annual divisible profits based upon the average of the three preceding years immediately prior to purchase, although certain retaining conditions were attached to this clause, amongst which was one forbidding the purchase of certain portions of a railway system without the Company's consent. Competition by the Government against a private-owned railway was also prohibited. As a result of the Act a policy of Government ownership was definitely abrogated for a quarter of a century, but the Companies' accounts and balance sheets had to be sent to the Treasury. This Act of 1844 is also famous as giving legal status to the third-class passenger, for one train per day in each direction had to convey third-class passengers in closed carriages with seats, at a charge not exceeding one penny per mile. Half a hundredweight of luggage and children under three were allowed to accompany a third-class traveller without extra payment. Parliamentary Trains, as these trains came to be known as, were very effective when used by *Punch* or W. S. Gilbert to promote merriment. Stopping at all stations, if required, an overall speed of 12 miles per hour had to be maintained, the Board of Trade having the right to amend their schedules. There was no passenger tax on third-class passengers, but if any trains were run on a Sunday, provision was to be made for third-class passengers on the Sabbath also. It would, perhaps, be unfair to state that some railways made

travel deliberately uncomfortable by these trains, by making the seats of a somewhat hard nature. The Anglo-Saxon was not to be so discouraged, and competition between railways gradually led to the evolution of a third-class comfort and rate of travel not excelled for the same price in any other part of the world. That gradual evolution has already been traced in a previous chapter.[1]

As one result of the Act of 1844, the Great Northern Railway Act of two years later included a penny third-class fare in its schedule of charges, the fact that the third-class carriages were covered and possessed seats being especially mentioned. But after obtaining the sanction of Parliament, the good intentions of the promoters of this line appear to have lapsed during the following three years, for as directors and shareholders in their Bill of 1850, they sought to replace the penny fare by a threepenny one, but as they would then have had to comply with their statements as to carriages when charging the maximum, this latter seems never to have been done.

A Railway Board was set up in 1844 which should examine Railway Bills before their presentation to Parliament, but the duplication caused thereby resulted in the decease of this Board the following year.

The Railway Clauses Act of 1845 [2] aimed at the elimination of discriminating practices. Legislation at that time was directed to preventing any efforts at the co-ordination of railway services and made compulsory the permission by Parliament of any lease or sale which might achieve what was afterwards considered so highly desirable in the railway organization of the country. The earlier part of Government regulation of the railway industry referred, as will have been seen, primarily to the regulating of railway construction and was characterized by efforts to obtain sound finance and, in certain

[1] *Vide supra*, Chapter IX.

[2] An Act for Consolidating in One Act certain Provisions usually inserted in Acts with respect to the Constitution of Companies incorporated for carrying on Undertakings of a Public Nature, May 8th, 1845. 8 Vict. cap. 20.

cases, to prevent a too violent type of competition. From the middle of the forties, however, the main efforts at regulation centre around the problem of the preservation of competition, the thorny problem of whether railway A should be allowed to amalgamate with railway B. The legislators of that period appear to have had little or no knowledge of the competition of markets, the power of *laissez-faire* was yet strong enough to prevent any large scheme which might ultimately be regarded as tending towards a monopoly from being looked upon with favour at Westminster.

In 1845, a Royal Commission was appointed to decide on the question of the uniformity of gauge. The broad gauge could claim the advantage of speed, though with very definite limits, but no similar claim could be made for it on the score of safety, accommodation, and convenience of passengers. As regards expense, the narrow gauge was considered to possess the advantage, and it was maintained by the Commission, whose report appeared in 1846, that the latter appeared to be more convenient for the type of service demanded in the country.[1] At that time there were rather less than 300 miles of broad-gauge line in existence and about 1,900 miles of standard gauge. In 1846 was passed the Gauge of Railways Act,[2] making 4ft. 8½in. the future standard for this country, though the Great Western Railway and its proposed extensions are especially excepted. It is often forgotten that the same Act laid down a somewhat larger standard for Ireland, namely, 5ft. 3in. How different history might have been if the standard had been the same, and the connection between the two countries made stronger through increased trade by train ferries! It is, perhaps, curious that these two years saw the passing of legislation to obtain a uniform gauge and thereby facilitate running power working, and also legislation to a large extent aimed at defeating this object.

The Accidents Compensation Act of 1846 affected the

[1] *Vide supra*, Chapter IX.

[2] An Act for Regulating the Gauge of Railways, August 18th, 1846. 9 & 10 Vict. cap. 57.

railways, but as this can hardly be considered a piece of railway regulation, it is sufficient to note its existence. It serves us as a reminder that the policy of *laissez-faire* was beginning to wane by the forties.

The year 1845 had been notable as a year of proposed amalgamations, and 1846 was equally notable for the presentation to Parliament of over 500 Railway Bills, nearly 250 of which actually received the Royal Assent; this period came to be known to posterity as that of the "Railway Mania." By 1848 the number of navvies engaged on railway construction totalled 190,000.

Hadley tells us that "up to the end of 1843 there were 71 separate roads averaging a little less than 30 miles in length. In 1844 they came down to a 15 mile average, and in the four years 1844–47 there were chartered 637 separate roads with a total authorized length of 9,400 miles. No less than eleven projects were laid before Parliament for lines of railway through a single valley where only one could possibly go." [1]

The problem of amalgamation proved no easy one to deal with and a Select Committee was appointed to consider the principle involved, although the Railway Board, shortly afterwards defunct, still existed at that time. Since 1846 combination of railways has been a hardy perennial for three-quarters of a century, and he would be bold who would say that the question has now been dealt with finally.

The principle of amalgamation involved canal as well as railway transport, and it is of interest to note that even to-day this problem of the aid to monopoly, which is often involved with amalgamation, is still unsettled in the United States. In Great Britain the Railways Act of 1921 fearlessly carried our railways several steps nearer rail monopoly conditions, but this will be discussed in a later chapter.[2] To railway amalgamation our legislators of 1846 appear to have held no very strong objection, but to canal absorption by railway interests there

[1] *Railroad Transportation*. Arthur T. Hadley, 1885. Chapter VIII, p. 167.

[2] *Vide infra*, Chapter XII.

developed considerable opposition, which to a certain extent exists to-day.

In keeping with the number of Railway Bills promoted, several committees were appointed this same year to study various aspects of the railway position, and the late summer saw the formation of a second Railway Board which, though surviving longer than its predecessor, suffered abolition several years later.

The Railway Clearing System, which had first come into operation in 1842, received legal status by the Railway Clearing Act of 1850.[1] A short outline of the cause of the formation of the Railway Clearing House and its continuous progress may be seen elsewhere in this book,[2] but by 1850 it had been found essential that it should be accorded some legal status and possess some rules of government. These are set out in the provisions of this Act; amongst them is the procedure to be adopted for the admission of additional companies as members, or the retirement of existing ones. Thus early did Great Britain obtain a system which brought together on neutral ground representatives of all the important Railway Companies of the country, and the influence of the various Clearing House Committees towards the gradual amalgamation and absorption of the smaller lines should not be overlooked. In fact, it is doubtful if the numerous amalgamation proposals of the later forties would have proved as numerous as they did but for the formation of the Railway Clearing System in 1842.

Owing to the overbuilding of railways, which had occurred during the period of the railway mania, it is not surprising that Parliament was called upon to pass an Act in 1850[3] relative to the abandonment of mileage which showed no prospects of ever earning profits.

[1] An Act of regulating legal Proceedings by or against the Committee of Railway Companies associated under the Railway Clearing System, and for other purposes, June 25th, 1850, 13 & 14 Vict. cap. 33.

[2] *Vide infra*, Vol. II, Ch. V.

[3] An Act to facilitate the Abandonment of Railways and the Dissolution of Railway Companies, in certain Cases, August 14th, 1850, 13 & 14 Vict. cap. 83.

Great Britain, in this respect, got over its growing pains, so far as railways were concerned, many years before other countries which later were to be developed by railway enterprise.

In 1851 [1] was repealed the Act of 1846, which had constituted a Board of Commissioners to whom had been given powers to supervise railways. These powers had previously been held by the Board of Trade, in which they were again invested in 1851, since the Board of Commissioners had not been clothed with sufficient authority to exert its influence adequately.

The formation of a smaller London, Midland, and Scottish Railway might have been made in 1852, for the London and North Western and the Midland had come to an amalgamation agreement that year. South of the Thames, the London and South Western and the London, Brighton, and South Coast had also come to a similar agreement. Although these two specific schemes did not fructify, amongst the score of proposed amalgamations of that year, some did, and amongst the latter was the amalgamation of three lines to form the erstwhile North Eastern in 1854.

The senior service in 1853, which up to then had pinned its faith on marine transport, at last trusted itself to travel by rail, and by an Act [2] of that year naval forces were entitled to travel by rail upon the same terms as members of the sister service.

Very important evidence was given before the Cardwell Committee, which mainly dealt with private Bill legislation, amalgamation and through facilities, in the following year, 1853, by Samuel Laing, then chairman of the London, Brighton and South Coast, and formerly a member of the earlier Railway Board. He stated that previous defective railway legislation had caused a very

[1] An Act to Repeal the Act for constituting Commissioners of Railways, August 7th, 1851, 14 & 15 Vict. cap. 64.

[2] An Act to make better Provision concerning the Entry and Service of Seamen, and otherwise to amend the Law concerning her Majesty's Navy (so far as relates to Railways), August 15th, 1853, 16 & 17 Vict. cap. 69.

considerable loss to the community, which could be calculated at £10,000 a mile, or £70,000,000 as a whole.[1] The report of Lord Cardwell's Committee gives us one of the earliest instances of the fact that public feeling was gradually beginning to realize that railway combination was a policy bound to continue over a long period of time; the Report states that temporary competition of rival companies must inevitably lead finally to some sort of working agreement. A practical result of the Report of the Cardwell Committee was the setting up of a new form of procedure for the consideration of Railway Bills by Parliament, and the following year, 1854, saw the passing of a Railway and Canal Traffic Act.[2] This Act is of great importance as it compelled the Companies to afford reasonable facilities and not to show undue preference. There can be little doubt that with the rapid growth of the railway network during the forties many unreasonable and discriminating practices had grown up, with the result that Parliament was forced to adopt a sterner type of regulation by this Act of 1854.

Two comparatively unimportant Acts affecting railways were passed in 1858 [3] and 1859,[4] while in 1860 the Clearing House System was extended to Ireland,[5] but the next Act of real importance was passed in 1863. An Act was passed in 1863 supplementary to that of 1845, which became known as the Railway Clauses Act of that date, and aimed at amending the previous law so as to

[1] Select Committee's Report, 1854.

[2] An Act for the better regulation of the Traffic on Railways and Canals, July 10th, 1854, 17 & 18 Vict. cap. 31.

[3] An Act to amend the Law relating to Cheap Trains, and to restrain the Exercise of certain Powers by Canal Companies being also Railway Companies, August 2nd, 1858, 21 & 22 Vict. cap. 75.

[4] An Act to enable Railway Companies to settle their Differences with other Companies by Arbitration, August 13th, 1859, 22 & 23 Vict. cap. 59.

[5] An interesting though unimportant Act affecting railways was the London, Coal, and Wine Duties Continuance Act of July 22nd, 1861, 24 & 25 Vict. cap. 42, which made compulsory the marking on every railway entering London of a point 20 miles from the General Post Office.

bring up to date the conditions required. The question of working agreements may be mentioned as one of the most important found necessary, due to the great increase in railway mileage and the consequent large number of points where lines came into touch with one another. By this 1863 Act working agreements were permitted between two railways upon the assent of the Board of Trade and the approval of the shareholders concerned, express parliamentary sanction not being required in such a case, and the Board of Trade had power to cause a replacement of level crossings by bridges at the Railway Company's expense.

A Railway Construction Facilities Act, passed in the following year, 1864, permitted the construction of a railway by a certificate of the Board of Trade in lieu of an Act of Parliament, where the owners of the land concerned were willing. Previous to this date special authority had had to be obtained from Parliament. This Act was amended six years later.

In 1865 a Royal Commission was set up to inquire into charges made by railways and the preferences thereby arising, but the policy of *laissez-faire* still held sway and the Commission reported that they did "not consider it would be expedient, even if it was practicable, to adopt any legislation which would abolish the freedom the railway companies enjoyed of charging what sum they deemed expedient within the maximum rates, when properly defined, limited as that freedom was by the conditions of the Traffic Act." A majority report had advised strongly against Government purchase, but Sir Rowland Hill, in a minority report, advised the State to purchase.[1]

The Railway Companies Act of 1867 abolished the right of seizure of locomotives and rolling stock from a Railway Company debtor, such seizure having been far from uncommon with some of the small early Railway Companies. The position of the Railway Companies was made still more secure by the Railway Rolling Stock Protection Act of 1872, which exempted rolling stock, not the property of the Railway Company, from distress

[1] Devonshire Railway Commission Minority Report, 1865–6.

for rent, provided such rolling stock had displayed upon it conspicuously a metal plate, or other distinguishing mark, indicating its actual ownership. When the Great Central extension to London was opened in 1898, much of its rolling stock belonged to the Railway Rolling Stock Trust, Ltd., and carried plates to protect it from seizure. Bought on a system of hire purchase, it closely approximated to that of equipment trust bond financing in the United States to-day, where many of the new steel cars carry ownership plates until the time when they are finally paid for by the Company which operates them.

By 1868, Parliament had come to realize the necessity for a closer supervision of the railway industry through the presentation of accurate tabulated accounts and statistics, which should be presented at half-yearly intervals. The Regulation of Railways Act of that year made provision for this, and for the following forty-two years railway returns were based upon the requirements of this Act. At that date Railway Companies had not entered largely into such allied fields of transport service as dock management, hotel operation, or cross-Channel services, and it was due, primarily, to the necessity for making provisions for financial accounts relating to these subsidiary enterprises, that the Railway Companies' (Returns and Accounts) Act of 1911 finally swept these provisions away, but not until they had served as the community's main check on efficient railway operation for nearly half a century.

A further Regulation of the Railways Act was passed in 1871, which extended the provisions of the earlier Act of 1842, so that the Board of Trade inspections should be made of any additional lines or stations opened. This Act also defined the duties of the inspecting officers, and, in certain ways, amended the provisions of the earlier Act, especially with regard to the reporting of accidents, which was now made compulsory wherever a passenger train was involved, or in any case of accident which was likely to have caused loss of life or personal injury. On receiving such a report the Board of Trade was authorized to hold an inquiry, and any books or evidence in the

possession of a Railway Company could not be withheld, if relevant to the inquiry. The reports of these inquiries are finally presented to Parliament, and often contain valuable recommendations which have been acted upon by the Companies. The Board of Trade was not, however, given the power to enforce the adoption of these recommendations. The same year the Regulation of Forces Act [1] was passed, permitting the Government to take over the railways in time of national emergency.

Important amalgamations again figured in the Parliamentary programme of 1872, one case being the Lancashire and Yorkshire and the London and North Western Railways; and a second, the Midland and the Glasgow and South Western Railways. A Select Committee to inquire into these amalgamation schemes was set up, but once again the amalgamations did not succeed.

In 1873 a Railway and Canal Traffic Act was passed and set up the Railway and Canal Commission, which event may be said to mark a turning-point in the growth of railway regulation. This Commission was destined to survive for many years longer than the middle-nineteenth-century Railway Boards. This Act was intended to supplement the Act of 1854, especially in respect of rate regulation. Complaints arising from the 1854 Act were to be brought before three Commissioners in lieu of the law courts named in the earlier Act. An important provision was the availability to the public of the schedule of rates and fares.

The following year, 1874, saw the setting up of a Royal Commission on Railway Accidents, and nearly three years later its Report was made public, the main outcome of which was the Railway Returns (Continuous Brakes) Act of 1878.[2] The Post Office (Parcels) Act of 1882 legalized payments to the Railway Companies for services rendered by the conveyance of parcels.[3]

[1] The Regulation of the Forces Act, 1871, 34 & 35 Vict., August 17th.

[2] An Act to provide for returns respecting Continuous Brakes on Passenger Trains on Railways, June 17th, 1878, 41 Vict.

[3] Post Office (Parcels) Act of 1882, August 18th, 45 & 46 Vict.

The Cheap Trains Act, 1883,[1] resulting from the inquiry into the railway passenger duty by the committee set up in 1876, abolished duties on fares of one penny per mile in return for the inauguration of workmen's fares.

Any bodily injury liable to cause an absence from work on one of the three following days incurred by an employer of labour had to be reported to the Board of Trade under the provisions of the Notice of Accidents Act of 1884. This law, though not applying normally to railways which had been already completed, had to be complied with by those engaged on the construction of new lines, and is noteworthy as being one of the earlier Acts covering the safety of any railway employees.

A further Regulation of Railways Act was passed in 1889, which was destined to be all-important in assisting the British railways to attain their universally envied record of safety, combined with an equally envious record of long-distance high-speed travel. In accordance with this Act, trains carrying passengers had to be fitted with some form of automatic continuous brake, while the trains were themselves to be safeguarded from collision by the inauguration of the " block " system of working, and the interlocking of points and signals. Both these latter are referred to in detail in a later chapter.[2] It must not be supposed that such aids to safe working were not in existence before the passing of this Act, but the Act eliminated the possibilities of some railways dropping far behind the excellent safety standards of their neighbours and placed the British lines far ahead of foreign railway administration, as regards safe working.

The early eighties may be regarded as a milestone marking the first co-ordinated movement amongst the trading interests for lower rate levels. An important date is 1888, which marks the passage of the Railway and Canal Traffic Act of that year, being the outcome of recommendations made by the Select Committee of 1881 and 1882, the formation of which had been due in their

[1] In 1842 the Railway Passenger Duty Act had imposed a duty of 5 per cent. on all passenger fares.

[2] *Vide infra*, Vol. II, Ch. VIII.

turn to agitation by the traders for lower rates. Amongst the important recommendations of this Committee were the settlement of a uniform freight classification, which had previously required reference to many early Acts, and a requirement that the Companies should lodge their proposed scale of rates with the Board of Railway Commissioners.[1] An Act of 1888 abolished this Board of Railway Commissioners and transferred their duties to the Railway and Canal Commission which exists to-day, though shorn of some of its importance by the Act of 1921. A further result of this Act was the submission to the Board of Trade of a revised classification and a revised scale of maximum charges. Public hearings were conducted and these maximum and this classification served as a foundation upon which the several Rates and Charges Confirmation Acts of 1891 and 1892 were built. These rates came into effect at the beginning of 1893 and fixed maximum charges for terminal services. Other provisions dealt with cartage rates and the carriage of perishable traffic by passenger train.

Maximum charges and freight classification also formed the subject of the Railway and Canal Traffic Act of 1894, caused by the traders' opposition to the application of the maximum rates permitted by the Act of 1893, which was destined to suffer comparatively little amendment until 1912, when rates had to be increased to recompense the companies for their increased expenditure on the betterment of conditions and increased wages, arising from the strike of 1911. The very important precedent was included in this 1894 Act by which the onus of proof rested with the Railway Company as to whether any increase in the rate charged was reasonable.

Long hours of duty and the safety of the railway employees formed the subject of inquiry by a Select Committee in 1891, and the final outcome of its recommendations was the Regulation of Railways Act of 1893, which gave the Board of Trade power to intervene, not only in questions appertaining to the safety of passengers, which they had obtained by the Act of 1871, but also in

[1] *Vide infra*, Vol. II, Ch. XII.

questions relative to the length of periods of rest between periods of duty, or where hours of duty were unduly long. As a result of this Act, Companies could be required to submit schedules of duty hours, but since the passing of this Act the whole question of hours of duty has changed very rapidly, and national policies have standardized the hours of labour throughout the country to a far greater degree than was ever at that time dreamed of, but it is unquestionable that the Act was instrumental in reducing the number of hours worked by railwaymen, for, at any rate, twenty years after its passage.

The Light Railways Act was passed in 1896, having formed the subject of an inquiry the previous year.

In 1897, an Act which can hardly be described as a Railway Act was passed, which, however, very greatly affected the railways, for their employees were included in the Workmen's Compensation Act of that year, thus extending the legislation previously passed by Parliament in the years 1846 and 1880.

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CHAPTER XII

GOVERNMENT REGULATION, 1901–1925

The Railway Employment (Prevention of Accidents) Act, 1900, marked an effort on the part of Parliament to lower the human cost of rail transport, and required the Board of Trade to make such rules as would reduce as far as possible the dangers which cannot be entirely dissociated from railway work. Appeal against any such order could, however, be made by the Companies to the Railway Commissioners. As showing the sort of orders issued under the Act, in 1902 a series of rules came into force relative to the protection of permanent-way staff engaged on relaying work; the protection of points and rodding; the labelling of wagons; and the lighting of sidings and stations.

During the early part of the twentieth century several committees reported on questions relative to rail transport in the metropolis; the tube railways formed the subject of one, electrification of the Metropolitan and Metropolitan District Railways a second, and London Traffic a third.

From both the practical and the theoretical points of view, the report of a departmental committee on the question of whether bulk import trade, mainly in agricultural and dairy produce, had been given unduly preferential treatment proved of great importance.

At the beginning of 1907 there came into force certain regulations relative to the safety of men working in connection with shunting yards and train operation. These orders were made under the Factory and Workshop Act of 1901, and are interesting as showing the general trend of greatly increased interest on the part of the public in the conditions of service of the railway em-

ployees. The same tendency was shown by the recommendations of a Committee, which reported in 1907, and advised the fitting of brake levers on both sides of wagons. The original recommendation provided for a change-over period of seven, ten and twelve years according to the number of wagons owned. The suggestions of this Committee came under the clauses of the Railway Employment (Preventions of Accidents) Act of 1900. Even to-day there are many wagons in existence with one-side brakes, though for many years all new wagons have been fitted for either side brake operation.

An important decision was that of the Court of Appeal on March 10th, 1908, upholding the views of the Railway Commissioners that the working agreement between the Great Central Railway and the Great Northern Railway was ultra vires according to the Act of 1858. It is interesting to observe that only thirteen years later these two railways were forcibly combined by the Railways Act of 1921.

In 1911 came the important Railway Companies (Returns and Accounts) Act, which swept away the provisions of the earlier 1868 Act and replaced them with an entirely new set of accounts and statistical tables, which in their turn were replaced by the Ministry of Transport Act of 1919. Under this 1911 legislation, the railways were required to prepare accounts for the year ending December 31st, and although thirty-two different financial accounts had to be prepared, the greater part of the figures required were already at the disposal of the majority of the Railway Companies. The measure proved to a large extent a compromise, as there had been considerable agitation for further details as to railway operation, but the added expense needed to obtain these details might have endangered the Bill. The extent of the compromise may be seen by the fact that the provisions of the Act were not destined to last ten years, though it is only fair to add that events arising from the world war probably expedited their decease. It can, however, be said that the Act provided a stepping-stone to the provisions of the 1919 Act, which are dealt with also in the chapter which

concerns itself with railway statistical matters (Vol. II, Chap. XII).

A Departmental Committee on Railway Agreements and Amalgamations had been appointed in 1909 to consider and report " what changes, if any, are expedient in the law relating to agreements among Railway Companies, and what, if any, general provisions ought to be embodied, for the purpose of safeguarding the various interests affected, in future Acts of Parliament authorizing railway amalgamations or working unions." It reported in 1911 and generally favoured such working agreements as the Great Northern, Great Eastern, and Great Central Railways on the one hand, and on the other the London and North Western, Midland, and Lancashire and Yorkshire Railways, had entered into. These two sets of lines ten years later, by Parliamentary action, were forcibly amalgamated, but the other working agreement, much in the public eye in 1911, that between the Great Western and the London and South Western Railways, has not been assisted by later Government action. The Committee reported that the degree of competition then evident between railways was not necessarily advantageous to the public, and that in the long run the public would gain by a properly regulated system of co-operation which could often best be obtained by working agreements or amalgamations.

As regards the safeguards required in future Acts of Parliament, the report recognized the unified nature of the country's railway system and hence it was argued that any bona fide transfer of powers between Companies " should not be a matter requiring the consent of Parliament." Provisions for discharge of surplus staff were also formulated, and it was additionally recommended that only reasonable reductions of service could be permitted.

This same year was to mark the beginning of the series of industrial disputes between the employees and the owners as represented by the management. Dissatisfaction with the working of the machinery set up after the 1907 strike had led to the dispute of 1911, which

involved other transport interests than the railways. As a result a Royal Commission was appointed to report on the Railway Conciliation Scheme of 1907. A further, though more indirect result, of the 1911 strike, was the passing of the Railway and Canal Traffic Act of 1913.

This Railway and Canal Traffic Act of 1913 amended the 1894 Act of the same title by giving the Companies power to increase their rates and charges in cases where it could be proved that increased expenditure had been incurred as the result of improved labour conditions. As this Act created, to all intents and purposes, a precedent, it may not be out of place to mention that Mr. Buxton, then President of the Board of Trade, when introducing the Bill, stated that it would give effect to certain recommendations of the Railway Conference, concerning rates imposed for services heretofore rendered without charge. It was also hoped to give effect to such of the recommendations of the Departmental Committee on Railway Agreements and Amalgamations, which had been appointed as a result of the discussions of the Railway Amalgamation Bills of 1909, as could be embodied in general legislation. Finally, as mentioned above, it gave the railways increased charging powers under certain conditions.

As a result of the passing of the Railway and Canal Traffic Act, a 4 per cent. all-round rise in the level of rates came into force in July, 1913. The second section of the Act provided that "where on a complaint with respect to any increase (within the maximum) of any rate or charge under section one of the Railway and Canal Traffic Act of 1894, the Railway Company proves to the satisfaction of the Railway and Canal Commissioners

(*a*) that there has been a rise in the cost of working the railway, resulting from improvements made by the Company since the nineteenth day of August, nineteen hundred and eleven, in the conditions of employment of their staff; and

(*b*) that the whole of the particular increase of rate or charge of which complaint is made is part of an

increase made for the purpose of meeting the said rise in the cost or working ; and

(*c*) that the increase of rates or charges made for the purpose of meeting the rise in the cost of working is not, in the whole, greater than is reasonably required for the purpose ; and

(*d*) that the proportion of the increase of rates or charges allocated to the particular traffic with respect to which the complaint is made is not unreasonable ;

the Commissioners shall treat the increase of rate or charge as justified."

Thus was a very important precedent conceded, by which rates and charges were to be raised so as to keep conditions of employment for railwaymen to a certain level, when compared with other industries.

In 1913 the Loreburn Royal Commission was set up to study the question of Government relationship with the railways ; owing to the outbreak of war in the following year, its sittings did not continue. Although the results of the war proved far-reaching on the British railways, no important legislation occurred from the time of the taking over of the railways by the Government until after the Armistice had been signed.

In 1919 the Ministry of Transport Act was passed, setting up a Ministry of Transport, which was to take over the Railway Department of the Board of Trade and part of the Public Utilities and Harbour Departments, but several important provisions which had figured in the originally proposed Bill did not survive the various Parliamentary readings. It raised a number of important issues and showed that the Railway Executive Committee had served the nation well throughout its period of control of the railway system. Most of the recommendations related to the vexed question of payment of maintenance and especially that of extra wear and tear resulting from Government usage, which was not balanced by less than normal wear and tear elsewhere.

Under the Railways Act of 1921 a sum of £60,000,000 was to be paid to the railways in settlement of their

complicated claims against the Government for services rendered during the war and post-war period. About 23½ million pounds was distributed amongst the railways as a first instalment in 1921, 30 millions in the following year, and the remainder in 1923. The handing over of this amount proved an integral part of the 1921 Act.

The report of the Colwyn Committee, which had inquired into the various agreements made during the period of Government control between the railways and the Government, was made public early in 1921. The latter half of that year saw the bestowal of Royal Assent upon the British Railways Act, 1921. This Act, which has been destined to affect radically the whole railway organization of this country, is worthy of very detailed study if a correct perspective of the present position is desired, and, therefore, the rest of this chapter is devoted entirely to its consideration.

The British Railways Act of 1921 [1] is divided into Six Parts, as follows:—

Part 1. Reorganization of the Railway System.
Part 2. Regulation of Railways.
Part 3. Railway Charges.
Part 4. Wages and Conditions of Service.
Part 5. Light Railways.
Part 6. General.

To understand fully the various provisions of this all-important Act, it is desirable to recall the conditions under which the Act was passed, why an Act of this scope was ever called for and why it should take the precise form that it did.

Searching for underlying causes one has to go back some years, in fact the 1900 strike of railwaymen on the Taff Vale Railway in South Wales proved one of the seeds from which grew the demand for nationalization

[1] An Act to provide for the reorganisation and further regulation of Railways and the discharge of liabilities arising in connection with the possession of Railways, and otherwise to amend the Law relating to Railways and to extend the duration of the Rates Advisory Committee, August 19th, 1921, 11 & 12 George V, cap. 55.

which in its turn was largely responsible for the Railways Act. Admittedly a measure rejecting nationalization, at the same time it set up a type of organization intended to be capable, by its efficiency, of withstanding the attacks of nationalization enthusiasts. The Taff Vale case, as it is commonly known, is perhaps more important as a landmark in the history of the Labour Party than in railway history, but it is too often overlooked and due regard should be paid to its results, far-reaching as they have been.

Briefly told, the story is as follows. As a result of damage caused to the Taff Vale Railway, a small line in South Wales, primarily interested in coal haulage, the Railway Company commenced a civil suit for damages against the Amalgamated Society of Railway Servants, which has since become one of the constituent unions of the National Union of Railwaymen. The suit was successful and damages against the union were awarded to the extent of £42,000: thus it was established "that a Trade Union could be sued in its collective capacity and its corporate funds made liable for a tortious act committed by any of its officials or members who could be deemed to be its agents." [1]

The immediate result was the rapid increase of the popularity of the Labour Party: the Labour Representative Committee, numbering about 350,000 in 1902, had a membership of nearly a million in 1904. The General Election of 1906 was followed by the passing of the Trades Disputes Act of the same year, which legalized peaceful picketing, and "without any qualification or exception that no civil action shall be entertained against a Trade Union in respect of any wrongful act committed by or on behalf of the Union." [2] The Taff Vale case gave that stimulus to the Political Labour Party from which it has rarely slackened, and with its growth has also been the growth of the demand for nationalization of the means of production, which demand gives the

[1] *Trade Unionism*, by C. M. Lloyd, 1919.

[2] *History of Trade Unionism*, by Sidney and Beatrice Webb, Revised Edition, 1920.

railway industry credit for being productive, even if it gives it little credit otherwise.

Trade Unionism saw rapid growth during the years of the Great War, 1914–1918, and as a result there was considerable demand for railway nationalization upon the arrival of peace conditions. Owing to the continuation of Government control until March, 1920, time was obtained for the consideration of a future policy, but the natural reaction against Government control and operation of public services, which had been such a prominent feature of Great Britain in war-time, was found to be stronger than the desire for nationalization, and the result was the Railways Act of 1921. This Act may, in truth, be called a compromise since it failed to convert the British railways to State owned or operated lines, but it also failed to leave the lines or their organization in their pre-war state. Other causes also contributed to the desire for change. The lack of a standardized loading gauge had proved very troublesome during the war period, preventing free interchange of rolling stock; so also had the difficulties caused by the use of two brakes, the Westinghouse and Vacuum. The growing belief in the savings of large-scale enterprise, where a high percentage of overhead or fixed costs can be distributed over the maximum number of products, in this case passenger miles and ton miles, was also a big factor.

The examples of other countries all pointed in the same direction. The various German State Railways were being operated for all practical purposes as one railway, locomotive types, carriages, and wagons had been standardized, while loading gauges had been standardized for military needs years before. For many years each State railway had possessed its own territory and suffered little or no competition. Paris potatoes might come from Normandy or from Brittany, but there was little duplication of service offered. Even in the United States, where the Sherman and Clayton Anti-Trust Laws threatened the railways with dire penalties where combinations in restraint of trade were concerned, the Transportation

Act of 1920 had, as its underlying motive, the ultimate consolidation of the various railroad systems.

One other consideration is important in both Britain and the United States; it was realized that the change over to peace-time conditions might be difficult, and efforts must be made to eliminate the high charges which had to be paid to financially weak lines if they were to continue to operate. The Transportation Act of 1920 and the British Railways Act of 1921 were both designed to eliminate the problem of the weak line. The prosperous concern was, by the savings of large-scale production, to be able to carry the weaker with it. Looking back, the savings to be derived in this manner in a short time appear to have been greatly overestimated. Yet in the United States to-day, where consolidation was permitted to take place voluntarily, it is reported that Presidential policy favours a compulsory consolidation which will eliminate alleged high freight rates on agricultural products.

What does not appear to have received sufficient attention was the possibility of the trade flow altering, yet it has done so remarkably during the course of the last few years, a period in this country of almost unparalleled industrial depression. Thus small but wealthy mineral lines have been badly hit by falls in traffic receipts, while such passenger lines as the Great Eastern and the London, Brighton and South Coast Railways have been coping with record excursion and holiday traffic. The weak lines in some cases have been forced to give of their little to assist those that should have had much. In a similar way the opening of the Panama Canal has altered the flow of trade throughout the railway network of the United States and been largely responsible for the descent of the Chicago, Milwaukee and St. Paul into receivership.

The first duty then of the Railways Act of 1921 was to formulate some form of organization which could be regarded as comparatively permanent, to allow for the changes in the country's trade which had occurred since 1913, and to carry out the desires of the population, so

far as they could be judged, concerning the rail transport problem.

It should be noted that the growth of democratic government inevitably makes the last-named of these objectives more difficult of attainment. With the growth of the franchise a diminishing percentage of voters are capable of knowing the interior economy of any one industry. The recent Hoch Smith resolution in the United States requiring the rate-regulating body, the Interstate Commerce Commission, to conduct an investigation into the whole rate structure of the country, is a perfect example of how little the elected spokesmen of the people can understand the difficulties of passenger and freight rates regulation in a large country.

Part I of the Act of 1921, entitled "Reorganization of Railway System," deals mainly with grouping. Five underlying considerations seem to have guided the design of the groups. Firstly, the desire to keep together in one group those lines which had close working agreements in earlier years; thus, the West Coast partners, the London and North Western Railway and the Caledonian Railway, would naturally fall into one group, while the Lancashire and Yorkshire Railway had always worked in close connection with the London and North Western Railway; the lines of the two railways are closely interwoven in Lancashire, especially in the Preston and Bolton district. Attempts at amalgamation between the London and North Western Railway and the Midland Railway had occurred during the nineteenth century, and in the twentieth these had taken the form of working agreements; thus, it was in many ways natural that, in the final schedule of grouping, the Midland Railway was found to be included in the third, or so-called North Western, Midland, and West Scottish Group. With the Midland Railway naturally went its West Scottish partner, the Glasgow and South Western Railway.

Secondly was the desire to saddle the financially strong line with its weaker neighbour, and thus it was hoped to reduce somewhat the level of rates, the reduction in revenue being offset by a reduction of expenditure due

to the savings of large-scale production of transport service.

It is the natural disinclination of the strong line to take over the weak, except under very advantageous conditions, that prevents the consummation of any policy of voluntary amalgamation as was urged in the United States in 1920. Undoubtedly the general growth of railways in the country has been accompanied by a continuous policy of amalgamation, but the process had been slowing down for some years before the war and it is very doubtful to what extent amalgamation would have taken place if left to voluntary schemes, especially in view of the great traditions and *esprit de corps* built up by the individual British systems as they existed in 1913.

A tentative and earlier grouping proposal had considered the formation of a Scottish group independent of the English Companies, but the financial position of such a group would have left it in a somewhat inferior position to that of a combined London and North Western and Midland. The desire for financial equality could not be overlooked, and the proposed Scottish group became divided between the North Eastern and North Western and Midland groups of English lines.

Thirdly, there was the desire to eliminate, where possible, strongly competitive services where duplication could not be considered an economic advantage to the country. Close allied to this was the fourth consideration, namely, that of forming various areas of the country into territories served by a single Company.

Unlike the situation in France, where the imaginary lines dividing the "Reseaux" do not usually coincide with important main-line routes, the lines dividing territories served by the groups here often coincide with important routes of traffic; thus a line drawn from London to Birmingham may divide the spheres of influence of Euston—London, Midland and Scottish—and Paddington—Great Western Railway—but the service between London and Birmingham is very strongly competitive. A similar situation exists between London and Exeter,

London and Nottingham, Sheffield, and to a smaller extent Manchester; while the London and Glasgow and London and Edinburgh services may be regarded as distinctly competitive. Additionally, in Great Britain, the territories are by no means complete monopolies of rail transport. The Great Western territory is penetrated from the North as far as Bristol by the old Midland line, the old South Eastern and South Western ran into Reading, the old London and North Western reached Swansea, while North Devon and Plymouth were served by the London and South Western and Great Western Railways.

Liverpool, a centre on the North Western, Midland and West Scottish group, now known as the London, Midland and Scottish Railway, is also reached by the North Eastern, Eastern and East Scottish group, now known as the London and North Eastern Railway, by means of the Cheshire Lines Committee, jointly owned by the late Great Central, Great Northern, and Midland Railways. The West Highland line of the London and North Eastern Railway served a large area of Scotland, which one would expect to be given transport facilities by the London, Midland and Scottish. This latter line, however, in turn, penetrates to the east coast at Goole, Southend, and by means of the Midland and Great Northern Joint Railway, at Cromer, this joint line also giving it entry into Norwich. It also reaches York and Lincoln on its own lines and in the far north of Scotland serves both coasts. This lack of monopoly was partly due to the fifth, and very natural, consideration, that it was undesirable to transfer branches from one line to another. Any transfer of this character is bound to meet with difficulties, both financial and internal, such as the necessity for reorganization and lack of standardized practice, in such matters as signalling methods and loading-gauge requirements. It seems highly improbable that any important cases will occur where such branches as the Great Central branch into the Wrexham district, or the Great Northern branch to Stafford, will be transferred to the line into whose territory they penetrate.

In the Appendix will be found a list of the Constituent and Subsidiary Companies which were amalgamated to form the four big Companies of to-day. The directorate of the resulting Company was formed by election from the individual constituent Companies.

Two problems, as yet unsolved, still exist as a result of the provisions of Part I of the 1921 Act; firstly, the problem of lines jointly owned. Three important ones exist, namely, the Cheshire Lines Committee and the Midland and Great Northern, jointly owned, though the former not evenly, by the London, Midland and Scottish Railway and the London and North Eastern Railway, and the Somerset and Dorset Railway, jointly owned by the London, Midland and Scottish and the Southern Railways. At present they are run as independent lines, each having its own rolling stock, with the exception of the Cheshire Lines Committee, which utilizes the locomotives of one of the owning Companies. No solution of this situation which would be fair to both owning Companies has yet been arrived at, but it is doubtful whether the present position will continue indefinitely. The second problem is to what extent the Railways Act really intended to allot territories to each line. This question became acute during a recent year when both the London, Midland and Scottish Railway and the London and North Eastern Railway proposed the construction of rival lines in the borders of their respective zones, in the neighbourhood of Sherwood Forest. A compromise, with the possibility of a joint line, appeared to be the inevitable result. In times of trade depression such proposals are not likely to be repeated often, but if in the future a strong revival of trade occurs in this country such schemes may become common, and at present no ruling principle appears to exist as to the real intention of the 1921 Act in this respect.

Part I of the Act provided for the presentation of amalgamation schemes to the Ministry of Transport by January 1st, 1923. Such schemes were referred to an Amalgamation Tribunal, consisting of the three Commissioners appointed by the Act, for confirmation, which

was given power to formulate such a scheme if the railways concerned could not come to some agreement amongst themselves. The Amalgamation Tribunal acted as a court of record, its expenditure being limited to £35,000. It says much for those responsible for the financial guidance of the British railways that so many of the amalgamation schemes were completed with so little friction. It is a great achievement that with one or two exceptions, notably those of the Caledonian Railway (now part of the London, Midland and Scottish group) and the Midland and South Western Junction Railway (now part of the Great Western group), the full schemes of amalgamation were submitted to, and approved by, the Amalgamation Tribunal before January 1st, 1923, the latest date allowed. The two cases of dispute mentioned above were settled during the first eight months of 1923 and the Amalgamation Tribunal was able to dissolve in October of that year.

The Great Western, being the sole big line amongst the constituent Companies of the Western group, Part I of the Act specifically made provision for the constitution of the Great Western Railway as the amalgamated Company and permitted the increase of its loan and share capital, the additional capital ranking *pari passu* with the old. In all cases of amalgamation under this Act stamp duties were not payable, thus considerable expense was saved.

Table XIII (p. 256) shows the method by which securities of the railways amalgamated were exchanged for securities of the new Company. It will be noticed that the basis of exchange was that of earning power.

One important result of this method of exchanging securities has been the elimination of a large part, if not all, of the capital which had never been fully paid up. Table XIV (p. 256), compiled by the late Sir William Acworth, shows this.

The amalgamation schemes were to come into actual operation on January 1st, 1923.

A further most important provision of Part I was the setting aside of £60,000,000 of public money to be known

TABLE XIII.—Basis of Stock Transfers

	£100.	Exchanged for.
Debenture stocks	L.N.W.R. 3 per cent.	£75 L.M.S.R. 4 per cent.
	H.R. 4 „	£100 L.M.S.R. 4 „
	M.R. 2½ „	£62½ L.M.S.R. 4 „
	F.R. 3 „	£75 L.M.S.R. 4 „
	Cambrian R. 4 „ C. deb.	£70 G.W.R. 5 „
	S.E.R. 5 per cent.	£215 S.R. 4 „
Preference stocks	G.C.R. 6 per cent. (cons.)	£150 L.N.E.R. 4 per cent. (2nd guaranteed)
	L.N.W.R. 4 „	£100 L.M.S.R. 4 per cent.
	M.R. 2½ „ (cons.-perp.-pref.	£62½ L.M.S.R. 4 „
Ordinary stocks	L.N.W.R. consolidated	£100 ordinary L.M.S.R.
	M.R. deferred	£68 „ L.M.S.R.
	G.S.W.R. „	£34 „ L.M.S.R.
	F.R. consolidated	£30 „ L.M.S.R.
	M.R. pref. ordinary	£62½ 4 per cent. pref. L.M.S.R.
	Cambrian R.	£2 8*s.* 6*d.* ord. G.W.R.[1]

[1] Not ranking for dividend until 1929.

TABLE XIV.—Reduction of Capital

	January 1st, 1922.	January 1st, 1923.
L.M.S.R.[1]	455,292,862	335,297,585
L.N.E.R.	342,037,058	370,000,000
G.W.R.	147,256,336	136,242,555
S.R.	152,594,997	144,846,797
Total	1,097,181,253	986,386,937

[1] Contains Midland Railway.

as the "Railways Compensation Account" which sum was to serve as a full discharge and satisfaction of all claims any Railway Company in Great Britain might make for compensation under the Regulation of the Forces Act, 1871, and the Ministry of Transport Act, 1919, that is to say, for extra wear and tear, use, or damage caused to the Company since the taking over of the railway by the Government in 1914; the distribution of this £60,000,000 has been mentioned earlier in this chapter.

As a certain amount of misunderstanding has since appeared to exist in regard to the conditions attached to the handing over of this sum to the railways, this point is worthy of study in detail. The Act clearly stipulates that "All moneys received by any of the said Railway Companies in pursuance of any such scheme of allocation may be applied in such manner and in such proportions and at such time or times as the directors of the Company may determine as a reserve fund for meeting contingencies or for repairing, improving or maintaining any of the property of the Company, or for payment of interest or dividend, or for any other purpose for which the earnings of the Company may be properly applied." [1]

Income Tax only applied to so much of the sum concerned as was used for dividend payments. In actual practice the use to which this compensation fund has been put by the four Companies has been determined by the severity of the trade depression which commenced to lower, and which has continued with varying severity to damage the country's trade since 1921, and which shows little sign of lifting at the present time. As a result the railways have been forced to use this compensation money largely to support their credit, which would otherwise have suffered grievously as a result of declining revenue. Considerable expenditure, only made possible by this money, was required to overcome arrears of maintenance to track and rolling stock. Successive Governments have urged the Companies to stimulate the heavy industries of the country, such as iron and steel, and to reduce unemployment by forestalling their future

[1] Railways Act, 1921, Part I, Section 11, No. 4, page 14.

requirements. It is doubtful if such policies are economically sound since in reality they tend to prolong the period of falling prices, though in so far as such orders are placed at the point of the trade cycle when prices are at their lowest, the railway companies naturally obtain an advantage. The futility of such a policy to resuscitate the trade of the country is evident when the iron and steel trade after four years of this policy suffers from a depression as bad as that which existed in 1922.

In view of the extract from the Act quoted above there is little ground for the complaints that have appeared from time to time accusing the railways of not utilizing their compensation money to good advantage. The argument that such money should have been used to make good any deficit caused by a further lowering of rates or a deficit caused by increased wages would appear to have left out of account the reasons for which the money was granted.

A final section of Part I provides for any alteration in the position of the Railway Clearing House which might arise as a result of the grouping.

Part II, entitled "Regulation of Railways," gave the Railway and Canal Commission power to require a Railway Company to give reasonable railway services, facilities, and conveniences. But its major importance was in relation to the standardization of railway track, plant, and equipment, including methods of electrical operation, although any such changes were not to be allowed to affect prejudicially the interests of the stockholders by reason of heavy capital expenditure.

The lack of standardization of British railway operation is always noticeable to railway officers of other countries. Even in pre-grouping days the loading gauge varied not only between railways but between different lines of the same railway. Some railways favoured the Vacuum, others the Westinghouse brake; on some railways the driver's position was on the left-hand side, on others the right-hand side of the locomotive. Signalling practices varied greatly and so to a smaller degree did that of permanent way design.

The provisions of Part II were intended to assist in the gradual elimination of some of these anomalies of modern railway working and they also gave the Ministry of Transport considerable power to confirm agreements for the purchase, lease, or working of railways, and particularly referred to joint railways.

It is, however, under Part III of the Act that its provisions of greatest moment occur. Entitled " Railway Charges " it first defines the Constitution and the Procedure of a Railway Rates Tribunal. This Tribunal, consisting of three permanent members, has power to increase the number of its members. The permanent members may serve for a period of seven years, though they are eligible for reappointment. It is defined that one of the three be experienced in commercial affairs, a second in railway business and the third in legal business, the last named to act as President. Expenses are chiefly defrayed by fees, but if these are not sufficient the balance must be borne by the Railway Companies. The Tribunal is required to render an annual report to the Minister of Transport who in turn lays it before Parliament.

In addition to the permanent members of the Tribunal are two panels. One is known as the general panel, and consists of thirty-six members ; twenty-two representative of trading interests are nominated by the President of the Board of Trade, twelve representatives of labour bodies and passengers, nominated by the Minister of Labour ; the two remaining members are nominated by the Minister of Agriculture and Fisheries, and agricultural, horticultural and fishery interests.

The other, or railway panel, consists of eleven members nominated by the Minister of Transport after consultation with the Railway Companies Association, and represents the interests of the railway companies, and a twelfth member representing light and other railways not parties to the Railway Companies Association. Members of these panels are appointed for three years but are eligible for reappointment. Appeals from a decision of the Railway Rates Tribunal, in a similar manner to that of appeals against decisions of the Railway and Canal

Commission, go either to the Court of Appeal or the Court of Session.

As a result of the Act, the Railway Rates Tribunal has taken over much of the work of the Railway and Canal Commission since the former is given power to alter the classification of merchandise; vary or cancel through rates; institute, modify, or cancel existing group rates; vary toll payments; settle the charges for terminal services; determine the reasonableness of railway requirements; determine what could be conveyed as passenger luggage; and finally, determine the constitution of local joint committees.

As regards the classification of merchandise, this is dealt with more fully in the chapter of this book dealing with rates (Vol. II, Ch. VI), but the Tribunal under this Act was empowered to adopt a new classification which, however, has only just come into force. In connection with this classification was instituted a schedule of standard charges which shows the rates for the conveyance of merchandise, amounts of terminal charges, and fares for the conveyance of passengers and their luggage. The disintegration of the rate into conveyance and terminal charges is an important feature of this clause. These standard charges came into force on the so-called "appointed day," January 1st, 1928.

As regards exceptional rates under which a very large percentage of the country's freight and mineral traffic is estimated to move, these were to be abolished, except those which were not less than 5 per cent. below the standard charges and which have been agreed to by the trader and railway company, or claimed as desirable by the former, in which case the Tribunal is required to judge such case by its merits.

A clause which caused some difficulty was that which maintained that all rates not actually used during the two years prior to January 1st, 1923, were to be regarded as abolished. It was by no means easy for the trader to prove that non-application had been due to abnormal trade conditions or that equal rates were granted to other stations in the same group. Yet these were the only two

conditions under which these rates could remain. Any rates over 40 per cent. below standard charge can only be continued by permission of the Tribunal. It is impossible to deal in detail with the many provisions dealing with exceptional rates, it must suffice that the underlying considerations were three-fold; firstly, to reduce as far as possible the number of exceptional rates in operation, secondly, to prevent as far as possible any discrimination between the traders served, and, thirdly, to show the trader the compilation of his exceptional rate.[1] Thus, under the new régime the trader will know how much of his rate consists of conveyance charge, how much station terminal charges, and possibly the charges for private siding service.

Other clauses dealt with the conditions of carriage, owner's risk rates, through rates and fares, minimum rates, and the transport of dangerous goods, but only two other clauses of Part III merit close attention, the one relating to collection and delivery charges, the other to the adjustment of charges to revenue.

After the "appointed day" the railway company has been protected from having to collect and deliver all goods which are awkward to handle, the trader carting the easily handled goods, for from that time forward a railway only carted where an agreement to cart existed, that is to say, either the railway or the trader must handle all or none of the traffic.

The adjustment of charges to revenue is, perhaps, the most vital part of the whole Act; upon its success depends the credit of the railway industry, the consequent efficiency of that system, and the power of the country to compete in export trade. "The charges to be fixed in the first instance for each amalgamated Company shall be such as will, together with other sources of revenue, in the opinion of the rates tribunal, so far as practicable, yield, with efficient and economical working and management, an annual net revenue equivalent to the aggregate net revenues in the year 1913 of the constituent Com-

[1] The disintegration of an exceptional rate is only shown upon request.

panies and subsidiary Companies absorbed by the amalgamated Company" ;[1] and in addition a sum equal to 5 per cent. on capital expenditure, interest on which was allowed during the period of Government possession, an allowance for capital expenditure made since January 1st, 1913, and an allowance for capital expenditure which had not become fully remunerative by 1913.

In connection with this, expression is given to the hope that economies may be effected in working, owing to the amalgamations, allowance being made for 33 per cent. of them.[2] There can be little question that the savings likely to accrue within a few years were grossly overestimated, it not being realized apparently that there was comparatively little scope for economy in the reduction of, so called, competitive services from, say, London to Edinburgh, or London to Exeter, passing through totally different areas in the course of the journey.

Problems concerning the elimination of traders' wagons, of grease axle-boxes on all types of wagons, or the raising of demurrage rates to increase the daily mileage of wagons, were studiously avoided, yet such economies as these, though costly in capital expenditure for a few years, would have led to enormous savings at later dates.

It is too often forgotten that the tribunal is exhorted to fix charges so as to ensure the maximum development and extension, in the public interest, of the carriage by railway of merchandise and of passengers and their luggage. The tendency to decreasing railway revenue shows that comparatively little success has so far been achieved by the tribunal in this respect. The Act was wise in preventing the subsidization of ancillary services, such as dock working and hotel business by high rail transport charges, and the annual review by the tribunal of the standard and exceptional charges should prevent a policy of stabilization desirable to neither the railway, trading, nor national interests if carried to extremes. In case of the actual railway revenue exceeding the standard

[1] British Railways Act, 1921, Part III, 58 (1).

[2] There was an early time limit given by which time economies were to be effected.

revenue over a period of time, the standard charges will be so altered as to reduce this surplus by 80 per cent., in other words the trading interests and passengers will benefit to the extent of 80 per cent. of this surplus.

The feasibility of these provisions relative to standard revenue and their economic consequences is indefinite, because, with the "appointed day" only just reached, it is difficult to pass judgment upon this new method of ensuring an adequate rail transport system in this country.

Part IV is entitled "Wages and Conditions of Service," and attempts to grapple with a labour situation aggravated by the violent fluctuations in price level during the war, to which has been added a trade union system unequalled in its power and organization by that of any other country in the world, and hardly excelled by that of any other important trade or industry in this country. To attempt to solve this problem a complicated piece of industrial machinery has been set up under the Act, which may be said to commence with the Sectional Councils established on each Company, and dealing with the various grades of employees. The councils consist of railway officers and elected representatives of the men employed by the Company. They bear a close relationship to the Whitley councils set up in other industries, their main function being the elimination of grievances and misunderstandings as close as possible to the seat of the grievance. Questions relating to rates of pay, hours of duty, or other conditions of service of employees in default of agreement between the railway companies and the railway trade unions, which are fully recognized as representing the men, are referred firstly to the Central Wages Board, which is composed of eight representatives of the railway companies and eight representatives of the railway employees. The former are appointed by the railway companies, the latter by the railway trade unions, four by the National Union of Railwaymen, two by the Associated Society of Locomotive Engineers and Firemen, and two by the Railway Clerks Association. From the Central Wages Board the appeal goes to the

National Wages Board, composed of six representatives of the railway companies, six representatives of the railway employees, of which two each are appointed by the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Railway Clerks Association, while the Parliamentary Committee of the Trades Union Congress, the Co-operative Union, the Association of British Chambers of Commerce, and the Federation of British Industries, each nominate one member, these four members representing the users of railways, the whole Board being presided over by an independent chairman, nominated by the Minister of Labour. All railway employees come under the above scheme with the exception of the police, who have their own conferences with the railway companies' representatives, while it will be noticed that the shopmen are not represented on the two Boards, except in so far as the National Union of Railwaymen's representatives act for them. The position of the shopmen provides great difficulties, both to the trade union side and to the railway companies, since the majority of shopmen belong to their respective craft unions, such as the Amalgamated Engineering Union, the Carpenters Union, and so forth. Considerable friction appears to exist between these craft unions and the industrial union, the National Union of Railwaymen, and it is not surprising, since the principle of the craft union is diametrically opposed to that of the industrial union. It is somewhat startling that no provision was made in the Act for any regulation of shopmen's wages and conditions of service, and it is probable that this omission may be the cause of considerable trouble in the future.

Part V dealt with questions appertaining to Light Railways and is comparatively unimportant, since the mileage of light railway construction is not likely to be large in the future ; it cannot be said to have been large in the past in spite of the assistance given to this type of rail transport by the Light Railways Act of 1896. In a country as densely populated as Great Britain is, the great majority of branch lines require a frequent service

and often have to deal with a considerable traffic on certain days of the week, such as market days. On the other hand the system of roads, not equalled in any other country, with a large development of motor lorry and motor bus services, giving a door-to-door service has eliminated, except in rare instances, the need for light railway feeder service. In fact, from present appearances, where the revenue derived from many branch lines falls far below their operating expenses, it is probable that some of these lines will be closed and parallel road services substituted, thus following the example set by the Boston and Maine, and other lines in the United States.

Part VI contains various miscellaneous clauses, amongst which may be mentioned the provision of all reasonable facilities for exchange of traffic, and through rates and fares ; the main intention seems to have been to guarantee as far as possible the continuance, for five years, of the flow of traffic as it existed in 1914. Unquestionably, such continuous traffic was, in many cases, desirable but, at the same time, such a clause does not conduce to the rapid establishment of those economies about which so much was written when the grouping proposals were being discussed. Another provision of this Part gives added power to the Minister of Transport with regard to the collection and tabulation of statistics and accounts ; the remaining provisions are of comparatively minor or temporary importance, such as the one in schedule three, which protected the position of all those employed on the railway at the time of the amalgamation.

It is economically unsound that passengers and freight over other lines of the railway should subsidize the service on branch lines where the whole traffic could be adequately served by road transport.

The Railways Act of 1921 is the most recent piece of railway regulation, and as many of its provisions, especially relating to charges and revenue, have only just been put into force, it is too early to judge of its results. Similar in many respects to an Act passed the previous year in the United States, it has been regarded variously according to opinion, by some as a new charter for the

privately owned railway systems, by others as the last trial of that system, by still others as a midway step to nationalization. Be that as it may, it is unquestionable that its effects would have been far less strongly criticized if a period of trade prosperity had coincided with its advent rather than four years of trade depression.

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APPENDIX

CONSTITUENT AND SUBSIDIARY COMPANIES OF THE FOUR GROUPS

THE SOUTHERN RAILWAY COMPANY

Constituent Companies :—

London and South Western Railway Company ;
London, Brighton, and South Coast Railway Company ;
South Eastern Railway Company ;
London, Chatham, and Dover Railway Company ;
South Eastern and Chatham Railway Companies Managing Committee.

Subsidiary Companies :—

Bridgwater Railway Company ;
Brighton and Dyke Railway Company ;
Freshwater, Yarmouth, and Newport (Isle of Wight) Railway Company ;
Hayling Railways Company ;
Isle of Wight Railway Company ;
Isle of Wight Central Railway Company ;
Lee-on-the-Solent Railway Company ;
London and Greenwich Railway Company ;
Mid Kent Railway (Bromley to St. Mary Cray) Company ;
North Cornwall Railway Company ;
Plymouth and Dartmoor Railway Company ;
Plymouth, Devonport, and South Western Junction Railway Company ;
Sidmouth Railway Company ;
Victoria Station and Pimlico Railway Company.

THE GREAT WESTERN RAILWAY COMPANY

Constituent Companies :—

Great Western Railway Company ;
Barry Railway Company ;
Cambrian Railway Company ;
Cardiff Railway Company ;
Rhymney Railway Company ;
Taff Vale Railway Company ;
Alexandra (Newport and South Wales) Docks and Railway Company.

Subsidiary Companies :—
Brecon and Merthyr Tydfil Junction Railway Company ;
Burry Port and Gwendreath Valley Railway Company ;
Cleobury Mortimer and Ditton Priors Light Railway Company.
Didcot, Newbury, and Southampton Railway Company ;
Exeter Railway Company ;
Forest of Dean Central Railway Company ;
Gwendreath Valleys Railway Company ;
Lampeter, Aberayron, and New Quay Light Railway Company ;
Liskeard and Looe Railway Company ;
Llanelly and Mynydd Mawr Railway Company ;
Mawddy Railway Company ;
Midland and South Western Junction Railway Company ;
Neath and Brecon Railway Company ;
Penarth Extension Railway Company ;
Penarth Harbour, Dock and Railway Company ;
Port Talbot Railway and Docks Company ;
Princetown Railway Company ;
Rhondda and Swansea Bay Railway Company ;
Ross and Monmouth Railway Company ;
South Wales Mineral Railway Company ;
Teign Valley Railway Company ;
Vale of Glamorgan Railway Company ;
Van Railway Company ;
Welshpool and Llanfair Light Railway Company ;
West Somerset Railway Company ;
Wrexham and Ellesmere Railway Company.

THE LONDON, MIDLAND, AND SCOTTISH RAILWAY COMPANY

Constituent Companies :—
London and North Western Railway Company ;
Midland Railway Company ;
Lancashire and Yorkshire Railway Company ;
North Staffordshire Railway Company ;
Furness Railway Company ;
Caledonian Railway Company ;
Glasgow and South Western Railway Company ;
Highland Railway Company.

Subsidiary Companies :—
Arbroath and Forfar Railway Company ;
Brechin and Edzell District Railway Company ;
Callander and Oban Railway Company ;
Cathcart District Railway Company ;
Charnwood Forest Railway Company ;
Cleator and Workington Junction Railway Company ;
Cockermouth, Keswick, and Penrith Railway Company ;

Dearne Valley Railway Company ;
Dornoch Light Railway Company ;
Dundee and Newtyle Railway Company ;
Harborne Railway Company ;
Killin Railway Company ;
Lanarkshire and Ayrshire Railway Company ;
Knott End Railway Company ;
Leek and Manifold Valley Light Railway Company ;
Maryport and Carlisle Railway Company ;
Mold and Denbigh Junction Railway Company ;
North and South Western Junction Railway Company ;
North London Railway Company ;
Portpatrick and Wigtownshire Joint Committee ;
Shropshire Union Railways and Canal Company ;
Solway Junction Railway Company ;
Stratford-upon-Avon and Midland Junction Railway Company ;
Tottenham and Forest Gate Railway Company ;
Wick and Lybster Light Railway Company ;
Wirral Railway Company ;
Yorkshire Dales Railway (Skipton to Grassington) Company.

THE LONDON AND NORTH EASTERN RAILWAY COMPANY

Constituent Companies :—
North Eastern Railway Company ;
Great Central Railway Company ;
Great Eastern Railway Company ;
Great Northern Railway Company ;
Hull and Barnsley Railway Company ;
North British Railway Company ;
Great North of Scotland Railway Company.

Subsidiary Companies :—
Brackenhill Light Railway Company ;
Colne Valley and Halstead Railway Company ;
East and West Yorkshire Union Railways Company ;
East Lincolnshire Railway Company ;
Edinburgh and Bathgate Railway Company ;
Forcett Railway Company ;
Forth and Clyde Junction Railway Company ;
Gifford and Garvald Railway Company ;
Great North of England, Clarence, and Hartlepool Junction Railway Company ;
Horncastle Railway Company ;
Humber Commercial Railway and Dock Company ;
Kilsyth and Bonnybridge Railway Company ;
Lauder Light Railway Company ;

London and Blackwall Railway Company ;
Mansfield Railway Company ;
Mid-Suffolk Light Railway Company ;
Newburgh and North Fife Railway Company ;
North Lindsey Light Railways Company ;
Nottingham and Grantham Railway and Canal Company ;
Nottingham Joint Station Committee ;
Nottingham Suburban Railway Company ;
Seaforth and Sefton Junction Railway Company ;
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